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William Diller Matthew (1871–1930)

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WILLIAM DILLER MATTHEW[1]

(1871–1930)

BY WALTER GRANGER

[*Plate* 6]

Upon my return from the Gobi Desert in October, 1930, the first news received as I stepped from the train in Peking was that of the death of my old friend, colleague and chief, Dr. William Diller Matthew, on September 24, at Berkeley, California. Coming as it did, without my having had any intimation of the three months' serious illness which preceded his death, this news was like a bolt out of the blue. More especially was this true since after going to California in 1927 he appeared to have taken on a new lease of life. When I last saw him in Berkeley, in 1929, he looked and acted many years younger than when he left the American Museum, and those of us who felt his leaving most acutely were becoming somewhat reconciled to our loss because of this apparent improvement in his health and spirits.

Doctor Matthew was born in St. John, New Brunswick, on February 19, 1871, the second child of a family of eight—six sons and two daughters. His father was George F. Matthew, who for most of his life, up to the time of his retirement, was a member of the staff of the Canadian Customs in St. John, and an amateur geologist and invertebrate palaeontologist of high rank. His mother was a member of an old American family, the Dillers, of Brooklyn, New York.

In the Public Schools of St. John, Matthew received his preliminary

[1] President of The American Society of Mammalogists, 1926.

education. He then went to the University of New Brunswick where he was graduated in 1889 with the degree of A. B. Having determined upon a scientific career, he entered the School of Mines at Columbia University and took his Ph.B. degree in 1893. His Masters degree came the following year and in 1895 he gained his Ph.D. from the Department of Geology under Professor Kemp, having specialized not in palaeontology, but in more strictly geological and mineralogical subjects. He did, however, take the newly established course in vertebrate palaeontology under Professor Osborn, and this probably gave him his first leaning toward this subject. Then, immediately following his graduation, came his great opportunity, the one which turned him definitely into the channel that he followed to the end. He was appointed as assistant, under Dr. J. L. Wortman, in the Department of Vertebrate Palaeontology of the American Museum of Natural History, and thus early became associated with a collection of vertebrate fossils which, while small at that time, was destined to grow, before he left it, into the greatest in existence. He was made Assistant Curator in 1898, Associate Curator in 1902, Curator in 1911; and from 1922 until his resignation in 1927 he was Curator-in-Chief of Division I, comprising the Departments of Geology and Palaeontology. His first task at the American Museum was the identification, arrangement and cataloging of the accumulated collections made under Wortman, beginning in 1891, and to which was added shortly afterward the Cope collection. Matthew set a high standard for this important branch of museum work, a standard which was scrupulously adhered to in subsequent years, and the importance of which becomes more and more evident as the collection increases in size.

The identification of the collections made in 1892 and 1896 from the Paleocene of northern New Mexico and a restudy of pertinent material in the newly acquired Cope collection, led to Dr. Matthew's first paper published in the American Museum Bulletin, in fact, his first paper on Vertebrate Palaeontology—"A Revision of the Puerco Fauna." It is an interesting coincidence that his last paper to be published by the Museum, one on which he was writing the final pages when he was stricken with his fatal illness last summer, is also a revision of this same fauna, the material now more than doubled by recent collecting. He left this important memoir practically completed.

In 1905 Dr. Matthew married Kate Lee of Brooklyn, and shortly afterward moved from New York City, where he had always lived since his early Columbia days, to Hastings-on-Hudson. Here he built a home in a restricted area and among congenial neighbors. Here his family

of two daughters and one son was reared, and here his father and mother made annual winter visits from St. John, and family reunions were of frequent occurrence. Undoubtedly these earlier years at Hastings were the happiest of his life—living with his charming family amid delightful surroundings, still in robust health, and with his position in the scientific world becoming firmly established. Matthew was a home-loving man and most of his spare time was spent in caring for the place, in gardening, of which he was passionately fond, and in the entertainment of family and friends, and there were very few visiting palaeontologists, from home or abroad, who had not been at some time guests at the Hastings home, and who had not derived both pleasure and inspiration from their visits. To those of us in close association with him at the Museum the house was a Mecca to which we made pilgrimages as frequently as opportunity offered. In personality he was a quiet, unobtrusive man, almost bashful at times, but always sure of himself and stubborn in the defense of his ideas and ideals. A scrupulous honesty pervaded his private affairs and his scientific researches and writings, and he showed an intense loyalty to his Institution, to the tasks that he undertook, and to his friends.

To a stranger seeing Matthew in his office with his spectacles thrust up on his forehead, and a small fossil held close to his near-sighted eyes, he probably appeared as a typical scientist of the popular conception—a dry-as-dust person whose interests and understandings in life did not extend much beyond the specimens with which he was surrounded. But a brief acquaintance proved him, even to the casual observer, to be a man of wide interests and of high intellectual attainment. His extensive travelling and the wide scope of his reading enabled him to discuss intelligently and forcefully almost any topic that might be brought up. He could take up with equal enjoyment a treatise on the Mesozoic mammalia or a book of Stephen Leacock's stories.

In 1927, after having served for thirty-two years in the American Museum, Matthew was offered the chairmanship of the Department of Palaeontology at the University of California. I know that he found it a difficult thing to decide whether to accept or not. On one side there was the breaking away from the great collection which he had watched grow year by year until it had reached the position of first importance in the world; a collection over which he had been the constant custodian, which he knew better than did anyone else, and which had been the source of material and the inspiration for most of his voluminous writings. It meant also the breaking away, for himself and family, from the home

which they all loved, and from the great circle of relatives and long established friendships. On the other hand there were several advantages in the new position, and these eventually out-weighed the objections, and he accepted. The beginning of the fall term in 1927 found him established at the big round table in Dr. J. C. Merriam's old room in Bacon Hall. One of the arrangements that made it easier for Matthew to accept the new position was that for two months each summer he was to return to his old desk at the American Museum and bring to completion various important studies which he had left unfinished. It was while he was on his third summer visit, and just as he was struggling with the final pages of the manuscript of the first of these studies, that he collapsed and was hurried back to Berkeley, never to return.

There was never any question of Dr. Matthew's ability to carry on most successfully the curatorial and research work in California, nor of his ability to communicate his great store of knowledge to the advanced students, but I think that even he himself had some misgivings as to whether at the age of fifty-six he could take up the successful teaching of large classes of undergraduates, and this was one of the essentials of the position as offered. Before the first year at Berkeley was over, however, reports began to come to us of his enthusiastic reception by a class of 600 or more freshmen, and we knew that the thing had been accomplished, and that in addition to his many other attainments Matthew had become an efficient university teacher.

Matthew died just at the time of life when honors begin to come to men of high scientific attainment. Still he had already received many distinctions, among them the Presidency of this Society and of the Palaeontological Society. Undoubtedly the one which he prized most highly, however, was his election to Fellowship in the Royal Society of London, a merited honor in which his colleagues shared his own pleasure and pride.

Dr. Matthew's bibliography comprises some 250 titles. Most of these are on fossil mammals, but there are a few important contributions on dinosaurs and other reptiles, and one on the giant Eocene bird *Diatryma*. His best known work is probably his "Climate and Evolution" because the scope of this paper gives it a wider appeal than most of the others, but his very last work, the final revision of the Paleocene faunas of New Mexico, which is expected to appear in 1932, and which summarizes all that is known of these primitive and extremely important mammals, will undoubtedly be classed as one of his greatest contributions. As a popular writer on palaeontology Matthew had a decided

facility, and the pages of NATURAL HISTORY for many years were enlivened by his sprightly stories of new exhibits or new discoveries, and his series of popular handbook guides to the exhibition collections were gems of clear, condensed information.

Most of Matthew's technical papers were, of course, concerned with North American forms and faunas, but he always wrote with the related forms and faunas of other continents in mind, and I think I will not be disputed in saying that he knew more about the fossil mammalian faunas of the world than any other man. His thorough acquaintance with the great collections in America, his several visits to museums abroad, and his keeping up with the literature gave him a knowledge of the fossil mammalia of the world which was unparallelled. He knew fossils not only from the biological standpoint, but from the geological side as well. His fundamental geological training, begun under the tutelage of his father in New Brunswick and continued later at Columbia, gave him a splendid background for his field work, for Matthew was a collector as well as a curator. At one time or another, beginning in 1897, he visited most of the great fossil fields of the West, and several of his papers deal wholly or in part with the stratigraphy of the Tertiary basins of the Rocky Mountain region.

One of the great disappointments in Matthew's life was his failure to see the fossil fields of Mongolia, in which he had become greatly interested during his last years at the American Museum. His disappointment was all the keener because he did get as far as Peking in 1926, but only to watch from the Expedition headquarters the political disturbances and provincial warfare that prevented the party from taking the field that year. His only compensation, after the Expedition was finally abandoned, was the opportunity it gave to continue on around the world and visit Java, the home of *Pithecanthropus*, Calcutta with its important Siwalik collection, and the museums of Europe.

Matthew was always a believer in the exceptional value of large fossil faunas, feeling that one fairly complete picture of the life of a certain period in a given place was worth much more than mere glimpses of the life of many periods. His ideas in this matter are expressed in the last letter that I received from him, a letter written in the spring of 1930 on the eve of my departure for the last Gobi exploration. I quote a paragraph from this letter:

"I heard that you were going to try it again and I hope you will be able to make it. Particularly I hope that if you do get out you will be able to complete or extend the known faunas rather than discover new but inaccessible localities.

The more I see of fossil faunas the more I realize that you get more profit out of the few adequate and well known faunas than out of the multitude of faunules that we have to deal with. And that you can't have too much material."

Just what Dr. Matthew would have accomplished, if he had been spared another ten or fifteen years, is a matter of conjecture, but we can be sure that it would have been much. What he did accomplish during his thirty-five years of active scientific work is a matter of certain record, and this record places his name along with those of Cope, Marsh, Leidy, and Williston in the Hall of Fame of American Vertebrate Palaeontology.

SEASONAL ACTIVITY AND GROWTH IN THE DOUGLAS GROUND SQUIRREL

By Elton R. Edge

[*Plates* 7–8]

This paper deals with the seasonal activity, breeding, and rate of growth in the Douglas ground squirrel, *Otospermophilus douglasii* (Rich.). Data were obtained by field and laboratory observations and weekly trapping, supplemented by information obtained from farmers, county agricultural agents, and others. The observations set forth apply directly to the ground squirrel in central western Oregon and appear to hold good for the animals in other parts of their range. Number "0" steel traps were used in taking the squirrels. Ten to thirty traps were set in the entrances of burrows which appeared to have been used recently. In general an average of three or four traps would yield one squirrel. Shooting was also resorted to and found to be the best method if food data were desired. All specimens were measured, examined, and the skins preserved for further study. Published accounts dealing with the life history of *Otospermophilus douglasii*—Gabrielson (1), and Grinnell and Dixon (2)—either vary somewhat from the findings of the present investigation, or cover the points in question in a more general way. With respect to breeding habits and growth, Shaw (6) has described these for the Columbian ground squirrel, and Wade (7) for the thirteen-striped ground squirrel; but no work of this nature seems to have been published on the Douglas ground squirrel.

The Douglas ground squirrel has an inactive period extending from about the first of November to the latter part of February, but even in the middle of this period a few animals were outside their burrows on

DOUGLAS GROUND SQUIRREL

Upper: One day old. Lower: Two weeks old

DOUGLAS GROUND SQUIRREL
Upper: Four weeks old. Lower: Seven weeks old

warm days. Twelve burrows were dug out during the course of the winter of 1929–'30. Recently occupied nests were found in four of these. In one burrow the nest contained a supply of freshly cut blades of grass, in another a young female squirrel was captured as she was attempting to escape by digging. She appeared rather dazed as though she might have been in a light hibernation. In other burrows only old abandoned nests were found; however, it is possible that filled-in branches from these burrows may have led off to hibernating dens. A few squirrels began to appear in the fields by the first of March, but not before mid-March could the trapping be carried on with good results.

TABLE I

March 15: Three females, none pregnant.
March 22: Two females, neither pregnant.
March 27: Six females, none pregnant.
April 2: Two males; one female, not pregnant.
April 6: Three females, one not pregnant, one contained seven very small embryos, one had five medium sized embryos and two very small ones which appeared to be undergoing atrophy.
April 12: Three females, one contained three embryos, one contained five normal and one atrophying embryo, one pregnant kept under observation.
April 19: One male; four females, two not pregnant, one contained five embryos and one lactating.
April 26: One male; two females, both lactating.
May 4: One male; three females, one lactating, two not pregnant.
May 10: One male; nine females, six lactating, two not pregnant, one contained four embryos.
May 25: One male; three females, two lactating, one contained four well developed embryos.
May 31: Six males; nine females, six lactating, three not pregnant.

Probably there is some variation in the time of their appearance, corresponding to variations in the season. Trapping lists indicate that the females are active earlier in the season than the males. Table I shows that from the middle of March to the middle of April only two out of nineteen squirrels trapped were males. However, after the first of October more males than females were taken. This seasonal variation of activity in the two sexes is also shown in the data published by McCoy (4) for *Otospermophilus beecheyi*. This difference is probably caused by the necessity of the female to provide for the young in the spring. The continuing of this food gathering habit after weaning results in an accumulation of fat earlier in the fall.

Breeding did not seem to begin until late in March, when squirrels were observed chasing one another about the fields. Examination of captured specimens did not show pregnancy until early in April, and lactating females did not appear in the traps until late in April. The trapping record Table I shows something of the extent of the breeding season.

Checking of embryos in different stages of development indicated a gestation period of about twenty-five to thirty days. Attempts to obtain the period of gestation directly were not successful. Three females only superficially injured by trapping were used; two of these had been kept over winter while one had been taken early in the spring. About the first of April, when breeding seemed to be at its height in the field, these females were placed successively for two days each with a large male which had also been kept over winter. The cage of the male had previously been kept near those of the females to accustom them to each other. None of the females produced young. Close caging had apparently checked the appearance of the breeding instinct. The male and one of the females were not very shy, but neither were they tame. Ross' comments on the continued wildness of captured *Otospermophilus beecheyi* seem quite applicable to *douglasii* (5). These squirrels were in good physical condition, as they had been fed on dry bread, of which they appeared quite fond, and on carrots, apples, potatoes, green grass, and occasionally scratch feed and a few peanuts. Incidentally the three squirrels kept over the winter showed no inclination to hibernate, although they were kept in an open shed and subjected to temperatures as low as 15°F.

One pregnant female, taken April 12 and not badly injured by the trap, was placed in a cage and kept under observation. On April 18 she gave birth to five young, two males and three females. The average number of young as indicated by Table I is 5. Some of the smaller females contained only three embryos while some of the larger females contained 7. Probably the number of embryos is somewhat dependent upon the season and food conditions. In two cases the original number appeared to be undergoing reduction by foetal atrophy as the swellings of the uterus marking the points of attachment of the embryos were very much less in diameter than the normal ones and the size and number of supplying blood vessels were less.

The newly-born were relatively small, as can be seen by comparing them with the six inch rule (pl. 7). The skin was hairless, quite red and wrinkled; the eyes were closed and the movements were sluggish and

poorly coördinated. The 5 young, less than a day old, weighed 59 grams or about 11 grams each. Approximate weekly weighings and photographs were taken of the litter. One young squirrel disappeared the fourth week and search of the cage failed to reveal any remains. There was no chance for it to have gotten out but perhaps it was as Wade said of the squirrel family he had under observation—the mother "couldn't resist the little pink morsels and ate just one." Caged squirrels brought in from collecting trips ate the eyes out of dead companions and probably would have eaten other parts if left for any length of time without food. By the end of the second week fuzz had appeared on the body; the skin had taken on dark pigmentation; their movements showed better coördination; the eyes were still closed but bulged more, and vibrissae were appearing (pl. 7). After the second week hair appeared on the head and back, and by the end of the fourth week it was

TABLE II

April 18	1 day	11.8 grams
April 26	1 week	19.5 grams
May 3	2 weeks	24 grams
May 12	3.5 weeks	33 grams
May 18	4 weeks	35.2 grams
May 25	5 weeks	47 grams
June 2	6 weeks	53.5 grams
June 8	7 weeks	64.5 grams
June 15	8 weeks	73 grams

fairly thick, medium brown in color and showed numerous light gray spots. At the end of the fourth week the eyes were not quite open; the head was carried raised from the ground but the body was still in contact during their active shuffling around (pl. 8). By the end of the fifth week two had their eyes fully open and one barked at my hand as I took them out of the cage for weighing and photographing. By the end of the sixth week the young squirrels were quite active and only with difficulty could they be kept in the weighing pan; their tails had noticeably long hair but were not yet bushy. They supported themselves quite well, that is, their feet and legs were under their bodies and not sprawled out at the sides. At the end of the seventh week they were getting out of the nest rather frequently (pl. 8). By the end of the eighth week they were running around the cage a great deal during the day and appeared to be occasionally nibbling grass kept in the cage. Table II gives the average weight of individual squirrels at weekly intervals and approxi-

mate age. From the above data it may be assumed that in the field the young would venture out of the burrows approximately the seventh or eighth week and start supplementing the mother's milk with outside forage. After that time variable growth of the young would be expected, depending on the nature and amount of the outside food. The young began to get into the traps early in June.

Weights plotted against time give the following curve (The dotted line indicates the gain in grams over the previous weighing):

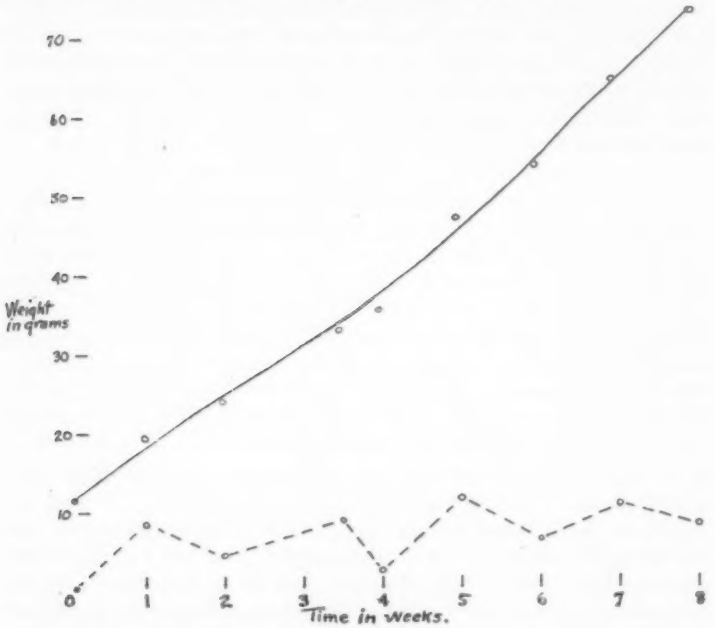

FIG. 1. DOUGLAS GROUND SQUIRREL

Unbroken line represents mean curve of growth of young. Dotted line represents gain in grams over previous weighing.

The weights given in Table II are believed to be fairly representative of those that occur under natural conditions as the mother was sleek and fat. She had been kept well supplied with green stuff in addition to the foods already mentioned. Water was kept in the cage but the mother was not observed to use it.

Weighings were not continued after the eighth week as the young squirrels had become too active to manage and were at an age when they would be taken in traps in the field. Their total length at this time was 210 mm., tail 85 mm. Measurements of skulls of individuals of various ages showed (as pointed out by Hall (3) for *O. beecheyi*) that the post-natal development of the skull is considerably greater in the pre-orbital region than in the post-orbital region, also that there is very little increase in palatine width.

SUMMARY

1. Trapping records, field and laboratory observations were made on *Otospermophilus douglasii*, chiefly of central western Oregon.

2. The inactive period of this animal extends from the first part of November to the last part of February.

3. The inactive period is not a profound hibernation.

4. The females are the first to become normally active in the spring and the first to become inactive in the fall.

5. Breeding season begins late in March and in general does not last much longer than one month.

6. The majority of young appear to be born about the middle of April.

7. The average number of young to a litter was 5 but this may be somewhat dependent upon favorable or unfavorable conditions.

8. The new-born young are hairless, wrinkled; eyes not open, movements sluggish; they weigh approximately eleven grams.

9. The gain in weight of the young averages from 8 to 10 grams per week.

10. The young leave the burrow about the eighth week, that is, early in June, and begin to forage on outside food.

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University of Oregon, Eugene, Oregon.

TRAVELS OF PEROMYSCUS

By O. J. Murie and Adolph Murie

Attention was first directed to the travels of mice rather accidentally by the senior author while camping on upper Whetstone Creek, Teton County, Wyoming, in the autumn of 1929. Some live traps were set about the camp ground, where *Peromyscus maniculatus artemisiae* were plentiful. Some of these mice were marked and released a short distance away. They reappeared in the traps, and were released repeatedly, at increasing distances, until rather surprising results were obtained.

Conclusion of field work for the season in this locality prevented further work at that time. In the summer of 1930, however, the writers were camped together in the same locality, and it was decided to carry on these investigations in greater detail. A large number of live traps were used, each mouse was given a number by means of punch marks in the ears, and the experiments were carried on more systematically.

THE HABITAT

The region about upper Whetstone Creek is typical of much of the Rocky Mountains. Extensive slopes and meadows are broken irregularly with clumps of trees, large and small, here and there coalescing into rather extensive forest areas. Our camp was situated at the edge of a rather heavy forest, consisting of Engelmann spruce (*Picea engelmanni*), Alpine fir (*Abies lasiocarpa*), and a limited number of lodgepole pines (*Pinus contorta*), at an elevation of approximately 7500 feet. This forest extends several miles up Whetstone Creek, over rough terrain, with fallen logs and rock débris in many places, and a certain amount of undergrowth. In front of our camp, to the east, lies a gently sloping sedge meadow, some 400 yards across. On the north side flows Whetstone Creek. On the south rises a steep mountain side, bearing a mixed growth of sedge, grass and herbaceous plants, with scattered clumps of Alpine fir. The slope culminates in Bobcat Ridge at an elevation of some 9000 feet. Our trapping operations centered about camp, at the edge of the forest, and the area involved extends west of camp, one mile upstream, and east and south, down as far as Pacific Creek, below the mouth of Whetstone, about four miles from camp.

OBJECTIVES

The object of our studies was first to determine how far a mouse would travel, when released at a distance, to return to the place of capture. Second, to obtain checks on their natural movements and to record age and other factors, designed to aid in the interpretation of the data.

FIG. 1. TRAPPING GROUNDS ON WHETSTONE CREEK SHOWING THE STATIONS AND THE DISTRIBUTION OF TIMBER

RESULTS OF WORK IN 1929

In the autumn of 1929 a total of 18 mice, *Peromyscus maniculatus artemisiae*, were ear-marked and released at varying distances. Only six or seven live traps, of the "Delusion" type, were used. On September 4 a mouse was ear-marked and released 100 yards from the place of capture. The following day it reappeared in the trap where it was first captured. This initial return, resulting from a casual experiment, encouraged further efforts. All the mice were trapped at camp. Distances were paced out, straight back through the forest, in as straight a line as possible over the rough ground. Captives were usually carried in a tin can,

placed in a pack sack or pocket, or, when the distances became greater, part way in saddle bags. Whenever a mouse returned from any given distance, it was next released at a greater distance, usually at least 100 yards farther, as shown in the list below. It will be noted in the list that returns were frequent from a distance of 350 yards. No. 6, beginning with a return from 200 yards, finally came back a distance of 600 yards. No. 7 managed to return 1100 yards, while No. 5 came back from a distance of 1 mile. No. 5 was released again across an open meadow, in the opposite direction, a distance of 300 yards and returned next morning.

It should be noted that some of the mice were released repeatedly at increasing distances in the same direction and presumably had opportunity to become familiar with the route. However, a number returned from an initial distance of at least 200 or 300 yards.

Following is a list showing the movements of mice which were marked and released during 1929.

No. 1. Returned 100 yards, Sept. 5 (dead in trap).
No. 2. Returned 150 yards, Sept. 5—Released 200 yds. distant but was not recaptured.
No. 3. Released 200 yards distant Sept. 6, but was not recaptured.
No. 4. Returned 200 yards, Sept. 10—250 yards, Sept. 11—300 yards, Sept. 12—350 yards, Sept. 13. Released 500 yards, Sept. 13 but was not recaptured.
No. 5. Returned 200 yards, Sept. 10—250 yards, Sept. 11— 300 yards, Sept. 12—350 yards, Sept. 13—500 yards, Sept. 15—600 yards, Sept. 20—1100 yards, Sept. 21—1300 yards, Sept. 22—1760 yards, Sept. 27—300 yards (in opposite direction), Sept. 28.
No. 6. Returned 200 yards, Sept. 12 (after 3 days)—350 yards, Sept. 14—500 yards, Sept. 15—600 yards, Sept. 18 (dead in trap).
No. 7. Returned 300 yards, Sept. 12—350 yards, Sept. 13—500 yards, Sept. 15—600 yards, Sept. 17—700 yards, Sept. 18—900 yards, Sept. 19—1100 yards, Sept. 22. Released 1 mile distant Sept. 22, but was not recaptured.
No. 8. Returned 300 yards, Sept. 13—500 yards, Sept. 22. Released 1 mile distant, Sept. 22 but was not recaptured.
No. 9. Returned 350 yards, Sept. 17, after 5 days (dead in trap).
No. 10. Released 500 yards distant Sept. 13, but never recaptured.
No. 11. Returned 600 yards, Sept. 27, after 11 days. Released 1300 yards, but not recaptured.
No. 12. Released 1100 yards distant Sept. 19, but never recaptured.
Nos. 13, 14, 15. Released 1300 yards distant Sept. 21, but never recaptured.
Nos. 16, 17, and 18. Released 1300 yards distant Sept. 24, 25, and 26, respectively, but never recaptured.

RESULTS OF WORK IN 1930

The work in 1930 was carried on much more systematically. About 60 live traps were used. Trapping was carried on first at camp, then along the edge of the woods above our camp, and finally along a stream, 400 yards distant, which for the purpose of this study we designated as Elk Creek. Occasional trapping

was done between these locations so as to cover the area completely. For some time we transported no mice, but ear marked each one and released it at the place of capture. This was for the purpose of marking the local mouse population as completely as possible, in order that any mice captured in future trappings might be identified and we might possibly obtain records of local, natural travels. A total of 158 mice were thus marked and recorded. Mice designated immature were in the gray pelage.

On August 28 we commenced transporting mice to a distance and trapping for returns. Since in the previous summer one mouse had returned a distance of one mile to the trap in which it was captured, we began to release the mice at that distance, or a little more, without working up to it by means of shorter intermediate steps. In reality, the place of release was about 2000 yards in some cases, since the place of capture was often 300 or 400 yards on the opposite side of camp.

A total of 40 mice were released one mile north of camp, and of this number four mice were recaptured.

No. 7, male subadult, captured several times, near camp; released August 30, one mile north of camp; recaptured Sept. 5, 400 yards on the opposite side of camp. No. 7 therefore in a period of about five days returned a distance of a little over 2000 yards—at least 400 yards past the point of previous capture.

No. 44, male subadult. Released Aug. 29, one mile north of camp; retrapped at place of previous capture on Elk Creek, Sept. 4. No. 44 in about five days, had returned a distance of slightly over 2000 yards.

No. 80, male subadult. Released Aug. 30, one mile north of camp; retrapped at place of previous capture on Elk Creek, Sept. 8. No. 80, in a period of 8 days or less, had returned a distance of slightly over 2000 yards.

No. 85 male immature. Released on Aug. 30, one mile north of camp; retrapped Sept. 7, near place of previous capture on Elk Creek, having returned a distance of slightly over 2000 yards in a maximum period of about 7 days.

Upon capturing the first return from a distance of about 2000 yards mice were released at greater distances:

No. 20, female adult. Captured at various points near camp, then captured again Sept. 6 on Elk Creek, nearly 400 yards from camp; released same date, one and one half miles south of Elk Creek (in opposite direction from the one mile station mentioned above); retrapped at camp on Sept. 8. This mouse had come back to camp, a distance of a little over one and one-half miles, in two days.

A total of 23 mice, including four of the long-distance travelers mentioned above, were released two miles south of Elk Creek. Of this number we obtained a single return. No. 124, female immature, captured at camp Sept. 9; released 2 miles south of Elk Creek on Sept. 10; retrapped 150 yards from camp on Sept. 12. No. 124 had returned a distance of slightly over two miles in about two days.

It will be noted that No. 20 and No. 124 had covered a greater distance in a much shorter time than the mice which traveled about one mile. It should be stated that the one mile returns traveled through a fairly heavy forest, while Nos. 20 and 124 had come from the opposite direction over a much more open terrain, much of it over open grassy slopes. This may or may not have been an influencing factor. The other mice may not have been captured at once upon returning.

Some even greater distances were attempted. Fifteen mice were trapped on Pacific Creek, 4 miles below camp, and were released at camp. Subsequent

trapping on Pacific Creek brought no returns. A final visit was made to Pacific Creek October 22. A number of mice were trapped, but none that was marked. However, we obtained some light on the movements of a few of these:

Nos. 1, 2 and 3. Trapped at Pacific Creek and released at camp, Aug. 21; recaptured at camp Aug. 22 (all dead in trap).

No. 113, male adult. Trapped at Pacific Creek and released at camp Sept. 6; recaptured on Elk Creek Sept. 9, about 400 yards in the direction of Pacific Creek.

No. 114 female immature. Trapped on Pacific Creek and released at camp Sept. 6; recaptured, dead, at camp Sept. 10.

No. 115 female immature. Trapped at Pacific Creek and released near camp on Sept. 7. Recaptured on Elk Creek, nearly 400 yards in the direction of Pacific Creek, Sept. 12.

No. 116 female adult. Trapped at Pacific Creek and released near camp on Sept. 7; recaptured at camp on Sept. 10.

No. 4, male subadult. Trapped at Pacific Creek and released at camp Aug. 21; recaptured within 25 yards of place of release Aug. 22; captured again at camp in the evening; captured again on Elk Creek, about 400 yards in direction of Pacific Creek, Sept. 17.

No. 112 male adult. Trapped at Pacific Creek and released at camp on Sept. 6; recaptured on Elk Creek, over 400 yards in direction of Pacific Creek, on Sept. 17.

It will be noted that four of these mice had at least started back toward the point of original capture 4 miles distant, and had traveled about 400 yards. Several others appeared to have lingered near the point of release. No. 116 had remained in the same vicinity 3 days, No. 114 had remained 4 days, No. 112 was found within 400 yards of place of release after 11 days, and No. 4 within 400 yards of place of release 26 days after release.

Elk Creek was a particularly desirable habitat for *Peromyscus* and it is possible that some of these mice, finding such a desirable location on their way back toward their original home grounds, were tempted to remain. Others evidently found the camp ground so favorable that they did not even start back.

SHORT TRAVELS

Nineteen mice captured at Elk Creek were released at camp, 400 yards distant. Of these, eight (2 im. ♀, 1 im. ♂, 4 subadult ♂, 1 adult ♂) were never recaptured. Two subadult males were recaptured 30 yards north of place of release eight days later; one immature ♀ recaptured 30 yards north of place of release two days later. An immature ♀ was captured 200 yards west of camp, fourteen days after release. This mouse had traveled parallel to Elk Creek.

Seven mice returned to Elk Creek, after being released at camp, a distance of 400 yards:

Mouse No. 47, ad. ♂, was transported to camp Sept. 3 and retaken Sept. 4 on Elk Creek, 50 yards from first place of capture.

No. 51, sub-ad. ♀, was transported Aug. 28; retaken on Elk Creek Aug. 31 at first place of capture.

No. 52, sub-ad. ♂, was transported Aug. 28; retaken Aug. 30, 35 yards from first place of capture.

No. 57, ad. ♀, was transported Sept. 3; retaken Sept. 10 at first place of capture.

No. 59, ad. ♀, was transported Aug. 28; retaken Sept. 3 at first place of capture; again transported to camp Sept. 3; retaken at Elk Creek, 25 yards from first place of capture.

The first time mouse no. 59 was transported it was brought to camp *while unconscious from the cold*. It did not revive for ten minutes after reaching camp.

No. 62, sub-ad. ♀, was transported Aug. 28; retaken Aug. 30, 15 yards from first place of capture.

No. 105, ad. ♂, was transported Sept. 3; retaken Sept. 5 at about first place of capture.

TENDENCY TO REMAIN IN NEW LOCALITY

Five mice were captured at distances varying from one half mile to one mile north of camp, and were released 275 yards south of camp. Two were never recaptured. Six days later a sub-adult ♂ was captured a short distance above camp, about 300 yards from place of release. An adult ♀ was captured on Elk Creek the day after release, 125 yards south of place of release. Six days later this mouse was captured on Elk Creek in the same trap as before.

An immature ♂, a few hours after release, was recaptured 100 yards south of place of release. The following day it was taken some distance up Elk Creek about 50 yards from place of capture the preceding night. Six days later it was captured only 10 yards from where taken last.

Mention has already been made of 15 mice brought to camp from Pacific Creek, a distance of 4 miles. Of these, one was found again at camp three days and another four days after release.

Some of the mice when taken to a new locality tend to remain instead of returning to their former home. Many of the mice had been trapped out of the area where these mice were released, so undoubtedly there were plenty of unoccupied homes.

HOME RANGE

Incidental to the study of the homing of mice above described, some data were secured pertaining to the home range of the mouse. These data are based on mice which were released at the place of capture and later retaken. In the records below reference will be found to distance traveled. By this is meant the distance from the new place of capture to the last place of capture and not necessarily from the original place of capture.

Trapping was not carried on continuously over any of the area, except at camp, where a few traps were set at all times. We trapped on Elk Creek on the following dates: Aug. 28, 29, 30 and 31, and Sept. 3, 4, 5, 6, 7, 8, 9, 10, 12 and 17. The ground between Elk Creek and camp was trapped only occasionally. Removing the traps for a day or so allowed the mice to travel freely. Individual mice were not retrapped often due to the fact that many were released at a distance from where they were caught and others died in the traps. Only five mice released on the general trapping area were never retrapped.

No. "a", Ad. ♂	Marked Aug. 24; retaken Aug. 25	50 yds. distant
No. 6, Subad. ♂	Marked Aug. 22; retaken Aug. 23	15 yds. distant
No. 9, Subad. ♀	Marked Aug. 22; retaken Aug. 23	15 yds. distant
No. 13, Ad. ♀	Marked Aug. 24; retaken Aug. 25	At same place

No. 19, Subad. ♀	Marked Aug. 24;	retaken Aug. 25	At same place
No. 27, Subad. ♀	Marked Aug. 26;	retaken Aug. 27	25 yds. distant
No. 29, Ad. ♂	Marked Aug. 26;	retaken Aug. 27	At same place
No. 35, Subad. ♀	Marked Aug. 28;	retaken Aug. 29	60 yds. distant
No. 36, Im. ♀	Marked Aug. 28;	retaken Aug. 29	At same place
No. 37, Ad. ♀	Marked Aug. 28;	retaken Aug. 29	At same place
No. 38, Im. ♀	Marked Aug. 28;	retaken Aug. 29	At same place
No. 41, Im. ♂	Marked Aug. 28;	retaken Aug. 29	60 yds. distant
No. 44, Subad. ♂	Marked Aug. 28;	retaken Aug. 29	90 yds. distant
No. 45, Im. ♂	Marked Aug. 28;	retaken Aug. 29	140 yds. distant
No. 53, Subad. ♂	Marked Aug. 28;	retaken Aug. 29	At same place
No. 55, Subad. ♀	Marked Aug. 28;	retaken Aug. 29	25 yds. distant
No. 56, Ad. ♂	Marked Aug. 28;	retaken Aug. 29	75 yds. distant
No. 78, Im. ♀	Marked Aug. 29;	retaken Aug. 30	50 yds. distant
No. 81, Subad. ♂	Marked Aug. 29;	retaken Aug. 30	At same place
No. 82, Im. ♂	Marked Aug. 29;	retaken Aug. 30	At same place
No. 84, Ad. ♂	Marked Aug. 30;	retaken Aug. 31	25 yds. distant
No. 39, Im. ♀	Marked Aug. 28;	retaken Aug. 30	35 yds. distant
No. 33, Subad. ♀	Marked Aug. 28;	retaken Aug. 30	100 yds. distant
No. 147, Subad. ♀	Marked Sept. 12;	retaken Sept. 17	75 yds. distant
No. 146, Im. ♂	Marked Sept. 12;	retaken Sept. 17	At same place
No. 145, Im. ♂	Marked Sept. 12;	retaken Sept. 17	At same place
No. 144, Subad. ♀	Marked Sept. 12;	retaken Sept. 17	At same place
No. 143, Subad. ♀	Marked Sept. 12;	retaken Sept. 17	50 yds. distant
No. 141, Ad. ♀	Marked Sept. 12;	retaken Sept. 17	At same place
No. 140, Subad. ♀	Marked Sept. 12;	retaken Sept. 17	At same place
No. 138, Subad. ♀	Marked Sept. 12;	retaken Sept. 17	25 yds. distant
No. 139, Subad. ♀	Marked Sept. 12;	retaken Sept. 17	15 yds. distant
No. 24, Im. ♀	Marked Aug. 25;	retaken Aug. 30	230 yds. distant
No. 60, Ad. ♂	Marked Aug. 28;	retaken Sept. 3	75 yds. distant
No. 58, Subad. ♀	Marked Aug. 28;	retaken Sept. 3	At same place
No. 47, Ad. ♂	Marked Aug. 28;	retaken Sept. 3	At same place
No. 46, Im. ♀	Marked Aug. 28;	retaken Sept. 3	At same place
No. 57, Ad. ♀	Marked Aug. 28;	retaken Sept. 3	50 yds. distant
No. 8, Subad. ♀	Marked Aug. 22;	retaken Sept. 7	35 yds. distant
No. 25, Subad. ♀	Marked Aug. 25;	retaken Sept. 17	60 yds. distant
No. 10, Ad. ♀	Marked Aug. 23;	retaken Aug. 24	15 yds. distant
		again Sept. 16	40 yds. distant
No. 5, Ad. ♂	Marked Aug. 22;	retaken Aug. 23	At same place
		again Sept. 12	At same place
No. 22, Subad. ♀	Marked Aug. 25;	retaken Sept. 1	At same place
		again Sept. 17	30 yds. distant
No. 23, Subad. ♂	Marked Aug. 25;	retaken Sept. 12	75 yds. distant
		again Sept. 17	At same place
No. 15, Subad. ♂	Marked Aug. 24;	retaken Aug. 25	At same place
		again Sept. 1	At same place
No. 16, Subad. ♂	Marked Aug. 24;	retaken Aug. 25	At same place
		again Sept. 1	At same place

No. 17, Subad. ♂	Marked Aug. 24;	retaken Aug. 25	75 yds. distant
		again Aug. 30	100 yds. distant, 175 yds. from original place of capture
No. 34, Ad. ♂	Marked Aug. 28;	retaken Aug. 29	50 yds. distant
		again Aug. 30	25 yds. distant
No. 43, Im. ♀	Marked Aug. 28;	retaken Aug. 29	50 yds. distant
		again Aug. 30	25 yds. distant
No. 11, Im. ♀	Marked Aug. 24;	retaken Aug. 25	At same place
		again Aug. 26	20 yds. distant
		again Sept. 16	At same place
No. 14, Ad. ♀	Marked Aug. 24;	retaken Aug. 25	At same place
		again Sept. 3	150 yds. distant
		again Sept. 16	At same place
No. 18, Subad. ♂	Marked Aug. 24;	retaken Aug. 25	At same place
		again Sept. 12	100 yds. distant
		again Sept. 17	At same place
No. 20, Ad. ♀	Marked Aug. 25;	retaken Sept. 2	150 yds. distant
		again Sept. 3	At same place
		again Sept. 8	400 yds. distant
No. 21, Ad. ♀	Marked Aug. 25;	retaken Aug. 28	150 yds. distant
		again Sept. 12	At same place (50 yds. from first place of capture)
		again Sept. 17	100 yds. distant
No. "b," Ad. ♂	Marked Aug. 25;	retaken Aug. 28	80 yds. distant
		again Sept. 1	100 yds. distant
		again Sept. 5	60 yds. distant (100 yds. from first place of capture)
No. 7, Ad. ♂	Marked Aug. 22;	retaken Aug. 23	25 yds. distant
		again Aug. 24	30 yds. distant
		again Aug. 25	At same place
		again Aug. 26	At same place
		again Aug. 30	30 yds. distant
No. 12, Im. ♀	Marked Aug. 24;	retaken Aug. 25	At same place
		again Aug. 26	10 yds. distant
		again Aug. 27	10 yds. distant
		again Aug. 30	15 yds. distant

The data indicate that these mice have a rather definite home range. This is shown especially in cases where a number of days intervene between the time of original capture and time of recapture. The following sample cases are especially significant in this respect: Mice No. 25, 10 and 22 were recaptured respectively 60 yards, 40 yards and 30 yards distant, 23 days after release; mouse No. 11 was recaptured at same place, 21 days after release; mouse No. 5 was recaptured at same place, 20 days after release; mouse No. 8, 35 yds. distant, 16 days after release; mice Nos. 21 and 14 were recaptured at same place, 15 and 13 days, respectively, after release.

Most of the mice were retrapped less than 100 yards from place of release. Only seven individuals had ranged farther than 100 yards when retrapped and one had moved 400 yards. Possibly this mouse had changed its home range. The fact that mouse No. 45 moved 140 yards in one night indicates quite a latitude of movement. Apparently the mice move about freely over an area 100 yards in diameter.

Within a distance of 300 yards along Elk Creek, 63 mice were captured in 4 days, 48 during the first two days. This would indicate much overlapping in the ranges of individuals.

CONCLUSIONS

It is, of course, extremely difficult to interpret behaviour of animals in the field, where it is not feasible to impose the control which is possible in the laboratory. However, several features can be pointed out in this field experiment.

The facts are that five mice actually returned to the place of capture a distance of one mile or a little more; one returned one and one-half miles; one returned two miles; and a much larger number returned from varying distances of several hundred yards.

Several explanations for such behaviour might be advanced:

The mice were sufficiently familiar with the terrain to find their way back.

The mice returned by chance.

The mice traveled back by means of a "homing instinct" or "sense of direction," whatever that may be.

Considering first the possibility that the mice were familiar with a large area, we found pretty good evidence that the home range of *Peromyscus m. artemisiae*, in a type of country such as that of Whetstone Creek, comprises an area about 100 yards in diameter, although a few ranged farther. Furthermore, it should be noted that one mouse which returned one mile and one which returned two miles were both immature animals, in the gray pelage, from four to eight weeks old. Considering that a young mouse spends much time in the nest after birth and that our trapping showed that mice spend rather long periods within a restricted area, these immature animals could hardly have had time to become familiar with an area some two to four miles in diameter. Most of the other far travelers were sub-adult. As a practical possibility, we would discount familiarity with terrain as a factor.

The factor of chance is sometimes hard to dispose of. Of a total of forty mice released at a distance of one mile, four, or 10 per cent, returned. This may indicate the possibility of chance—that the mice simply began to wander in various directions and that some of them chanced to find their home territory.

It might be pointed out, however, that our trapping indicated that a certain percentage choose to remain at or near the point of release, and that a certain number of others appear to encounter a satisfactory habitat *en route*, and stop there. There is to be considered also the possible mortality from predatory species. We know, for instance, that at least two small weasels were prowling about our camp, for we caught them in the live traps. Furthermore, it is not always certain that the trap captures all the mice in its vicinity.

Considering all these factors, which workers in the field find more impressive than the mere statements would indicate, the percentage of returns mentioned above would be considerably increased.

Fifteen mice had been brought to camp from a distance of four miles. Four of these were subsequently retrapped at camp, dead, and another appeared to have lingered at camp, while four others, to our knowledge, appeared to have taken up their abode on Elk Creek. This leaves only six not accounted for and might indicate that only a small percentage really travel very far from place of release. Of the ten mice which appeared to have left camp, at least four traveled 400 yards in the same direction, which was toward their old home.

We did not determine whether or not the mice radiate in all directions when released at a great distance. The evidence we have tends to show that they travel largely in *one* direction, the one toward their home locality.

Finally, we have the record of a single mouse released at a distance of one and one half miles, which returned.

Our data would appear to show that although various factors probably influence the choice and actions of the mice released, mere chance wandering does not satisfactorily account for the ability of a certain number of mice to return to the original place of capture from distances of one to two miles.

One is tempted to believe that a "sense of direction" or "homing instinct" plays some part in the actions of these mice. The mere fact that several mice returned to the same group of traps from long distances, including one and two mile records, would naturally predispose one to consider some ability in orientation. It is difficult to define what we mean exactly by a homing instinct. We are familiar with the abilities of homing pigeons, migratory birds, and certain insects. Whatever such abilities may be called, it seems likely that mammals share them, at least to a certain degree. The desire to return to the home range no doubt varies with species as well as with individuals, but at any rate our data appear to show that the deer mice have a remarkable ability to find their way home over long distances.

Our experiments were by no means complete. Much work should be done to eliminate confusing factors. The subject is an interesting one, however, and it is hoped others will improve the technique and contribute further information.

THE OCCURRENCE OF TWO SUBSPECIES OF THE SAME SPECIES IN THE SAME AREA

By Lee R. Dice

Most vertebrate zoologists consider the terms subspecies and geographic race to be synonymous. The geographic range of a variable species is, according to this conception, divided into two or more divisions, each of which is occupied by a subspecies. Adjacent subspecies, where their ranges meet, are presumed usually, though not always, to intergrade, and the occurrence of intergradation to prove that the forms in question are subspecies. If no intergradation occurs between adjacent forms, they are considered to belong to different species, unless they are presumed to be connected by intergradation elsewhere, either with another subspecies or through a chain of related subspecies. This definition of subspecies has been adopted by most mammalogists and ornithologists, and to some extent it is followed by herpetologists and ichthyologists. Invertebrate zoologists are tending to adopt the definition of the vertebrate zoologists, if they recognize subspecies at all.

There is some dissent from this practice among vertebrate zoologists, and C. Hart Merriam[1] would distinguish between species and subspecies on the basis of degree of difference, rather than on the presumed occurrence or absence of intergradation, which in his opinion can seldom be fully demonstrated. He agrees, however, in considering a subspecies as a geographic race. On the contrary, botanists do not consider a subspecies or variety to be a geographic race, and often report two or more subspecies as occurring together on one area.

According to the usual geographic concept of subspecies employed by zoologists, no two subspecies of the same species should, except under extraordinary conditions, occur in the same area; for if they should occur together they would be expected to interbreed and lose their distinctness. However, a few cases of two presumably related subspecies occurring in the same region have been reported for the mice of the genus *Peromyscus*.

Along the eastern border of Glacier National Park, Montana, two subspecies, *Peromyscus maniculatus artemisiae* and *P.m. osgoodi* (*nebrascensis* of Osgood) are said by Osgood[2] to occur together, *artemisiae* living in the forests and *osgoodi* in the sagebrush.

[1] C. H. Merriam, 1919, Jour. Mammalogy vol. 1, pp. 6–9.
[2] W. H. Osgood, 1909, U. S. Dept. Agric., N. Amer. Fauna, no. 28, pp. 59–60.

In the Puget Sound region of Washington two other subspecies of *Peromyscus maniculatus* occur together over a wide area.[3] The relationships in nature of *P.m. austerus* and *P.m. oreas*, the two forms in question, have not been critically studied, but there is possibly some difference in habits or habitat which prevents free interbreeding. Another case of overlapping without intergradation mentioned by Osgood[4] is that of *algidus* and *borealis* (*arcticus* of Osgood) in northwestern Canada. The occurrence together of *osgoodi* and *nebrascensis* (*nebrascensis* and *luteus* of Osgood[5]) in some localities on the Great Plains is perhaps a similar case.

In this same species, *Peromyscus maniculatus*, there can now be added another instance of overlapping without apparent intergradation. The subspecies *bairdii* is widely distributed over the upper Mississippi Valley, where it lives in the prairies and also in cultivated fields. In Michigan it is found commonly along sandy lake beaches as well as in open fields. The subspecies *gracilis* is a northern form living in heavy forests. In Charlevoix County, Michigan,[6] both subspecies occur, *bairdii* confined to the lake beaches, and *gracilis* restricted to the forest. Both forms may occur in buildings.

Near Ann Arbor, in the southern part of Michigan, a few *bairdii* occur in open fields and meadows. Some winter-taken specimens of *Peromyscus* from this region have long been suspected to be *gracilis*, but it has seemed unwise to extend the known range of the subspecies so many miles without more positive evidence. This evidence is now at hand. A female *Peromyscus*, identifiable by general appearance as *gracilis*, was taken alive in a woodlot near Ann Arbor by W. L. Strunk in the summer of 1929. This female proved fertile when mated with a male *rufinus* from stock taken in Colorado. This stock of *rufinus* had previously proved fertile when mated with undoubted *gracilis* from northern Michigan. On the other hand all attempts to interbreed the subspecies of *Peromyscus maniculatus* with *Peromyscus leucopus noveboracensis*, another species occurring in the woods at Ann Arbor, have resulted in failure. We thus demonstrate by breeding that the female in question is a member of the species *maniculatus* rather than of the species *leucopus*. Further, the size of its ears, its white nose, and bright colors, show it to be *gracilis* rather than *bairdii*.

[3] Osgood, *op. cit.*, pp. 52–53.
[4] *Op. cit.*, p. 50.
[5] *Op. cit.*, p. 78.
[6] L. R. Dice, 1925, Occ. Papers Mich. Mus. Zool., no. 159, pp. 22–24.

The subspecies *gracilis* in Charlevoix County, Michigan, lives chiefly in the virgin hardwood forest, and under primitive conditions it was probably common in southern Michigan. The clearing of the forests probably has been a contributing factor in the reduction of its numbers in the southern part of the state. Over an extensive area in southern Michigan *gracilis* and *bairdii* must still occur together, but *gracilis* is confined to the heavy forest and *bairdii* to the open spaces. In nature the two subspecies come into contact probably only rarely, and there is no evidence that intergradation between them occurs in Michigan. The reason for considering them to be subspecies, rather than full species, is that *gracilis* is said to intergrade westerly with *borealis* which in turn intergrades with *osgoodi*, *osgoodi* with *nebrascensis*, and *nebrascensis* with *bairdii*.

That *Peromyscus maniculatus gracilis* is closely related to *P.m. bairdii* is shown by the fact that when bred in the laboratory these two forms produce fertile offspring. However, it seems obvious that the short-tailed, prairie-dwelling subspecies—*bairdii*, *nebrascensis*, *osgoodi*, and others—represent a group within the species *maniculatus* different from the group comprising the long-tailed forest-dwelling subspecies—*gracilis*, *borealis*, *artemisiae*, and others. In two states, Michigan and Montana, where these two groups come into contact, no intergradation occurs.

Hybridization between adjacent geographic races is certainly not so common an occurrence in nature as has been supposed. For instance, I found no intergradation between the subspecies *blandus* and *rufinus* on the western slope of the Sacramento Mountains in New Mexico.[7] Osgood[8] states in regard to this case that "although the line may be drawn quite sharply between the two forms (*blandus* and *rufinus*) there is only a slight color difference and this is practically bridged by the variation in *rufinus* from different elevations." In this case he is considering the intergradation between the two subspecies to consist of an overlapping of the range of variability in taxonomic characters rather than of an actual interbreeding of the two populations. It is highly important in any consideration of the phylogenetic relationships of subspecies or other taxonomic division, or in any study involving ecology, that these two sorts of intergradation be kept distinctly in mind.

The overlapping of curves of variability is obviously the only kind of intergradation which can occur between the populations of an island and of the mainland or other islands. This is true of all cases of discontin-

[7] L. R. Dice, 1930, Occ. Papers Mich. Mus. Zool., no. 213, p. 31.
[8] Osgood, *op. cit.*, p. 85.

uous ranges; intergradation in the form of interbreeding cannot take place between the animals inhabiting isolated areas within the range of the species. Nevertheless, the populations of many islands are identical in taxonomic characters, so far as can be determined, with the populations found on the adjacent mainlands.

As to the significance of geographic races there are two possibilities: the two forms found interbreeding in the area between their respective ranges may once have been taxonomically distinct, and have later come into contact through migration or the removal of a barrier. In this case they must be still so closely related as not to have developed any physiological or psychological barrier to the production of hybrid offspring. In the second possibility, the two intergrading forms may be considered to represent a widespread species, which over part or all of its range is now undergoing evolutionary change. The changes taking place in this latter case would be in part occurring in spite of the hindering effect of constant interbreeding with one or more adjacent geographic races. It is possible that both of these modes of origin of intergradation may occur in nature, but to obtain positive proof of the method of origin for any particular case of intergradation is difficult.

The occurrence of intergradation is not denied, though its frequency is questioned. There is abundant evidence that intergradation does occur in many groups of animals, and in the genus *Peromyscus* it has been demonstrated statistically by F. B. Sumner[9] in *Peromyscus polionotus* in Florida and Alabama.

It is quite likely that there are many kinds of intergradation in nature. The rather sharp line of intergradation between *polionotus* and *albifrons* described by Sumner is very different from the very gradual integradation between *leucopus* and *noveboracensis* described by Osgood.[10]

Critical studies should be made of all presumed cases of intergradation, and special attention should be directed to the possibility of there being differences in physiology, habits, or habitats between the two intergrading forms, which might form a barrier to free interbreeding in nature.

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[9] F. B. Sumner, 1929, Proc. Nat. Acad. Sci., vol. 15, pp. 110–120, 481–493.
[10] Osgood, *op. cit.*, p. 115.

FOOD HABITS OF THE PACIFIC HARBOR SEAL, PHOCA RICHARDII

By Theo. H. Scheffer and Charles C. Sperry

In the Journal of Mammalogy, February, 1928, we gave some account of the food habits of the Harbor Seal from laboratory examination of 35 stomachs collected mainly in the lower part of Puget Sound. Since then we have been able to bring together an additional collection of 100 stomachs mainly from various parts of the Puget Sound and from Willapa Bay, on the southwestern coast of Washington. This collection has been made largely through coöperation with bounty hunters who take the seals for their scalps. Profiting by the experience of the first collection, we endeavored to procure this time only such stomachs as appeared to contain food, omitting also those of the young seals, which would have only curdled milk, as indicated by previous examinations.

Difficulties in securing seals at all seasons of the year and in all localities that might offer variations in the food habits have seemed almost insurmountable. Even under the more favorable conditions of location, weather, and tides that will induce a hunter to try for a kill, thirty to forty per cent of the animals shot can not be recovered for scalping, as they often sink almost at once in the deeper water. The most favorable conditions obtain mainly in June, July, and August, with calm seas and in the shallower waters frequented by the seals. It is extremely difficult to take a seal in the flow of an estuary by shooting. When taken by other means, on account of the delay in securing them, they are usually found to have empty stomachs.

Contrary to occasional reports from particularly prejudiced sources, seals constitute no exception to the rule in animal life of feeding in season and place upon the things that are the most readily obtained and suitable to their needs. Such with them are the many kinds of fishes, squids and octopuses, crustaceans, and a few other creatures living in shoal water bays or near the surface farther out.

They are able to capture salmon in the crowd of spawning runs up the estuaries of the larger rivers, but under other natural conditions can scarcely secure any but weaklings. Their habit of rearing head and shoulders above water to shake loose a bite from a larger fish, or to snap off its head, attracts attention while their ordinary feeding habits remain unobserved.

Seals are not slow to catch the idea of getting a dinner with little trouble by following the drift of a gill net or the wake of a trolling spoon

and taking the fish that are trammeled. They will also rob set nets and have been known to enter a fish trap, dine on salmon, and escape by the way they came in. But these are the predatory exploits of individuals that have learned the trick and profit by following it up so long as the fishing is good. It is the better part of wisdom to dispatch such pirate seals at the first opportunity; for they are persistent in these annoying habits, which are responsible above all other things for bringing them into disfavor with the fishermen.

The seal's habit of feeding commonly in the tidal reaches about the mouth of a stream tends to reduce in numbers or frighten away predators upon the young salmon fry that are swarming about before dispersal in the salt water. Any fish culturist will agree that the enormously preponderant losses in fish propagation occur in the egg stage or when the young fry are learning to dodge the foes that are besetting them on every side. From the evidence of other studies in the struggle for existence among animals it is not at all unreasonable to assume that the seal will save alive many more salmon by preying upon the enemies of the young fish than it will have opportunity to catch when of edible size. To strengthen this assumption with factual data will require, in turn, a study of the food habits of the creatures preyed upon by the seals in their activities about the influx of spawning streams. Certain it is that balanced relations were sustained between salmon and seals in the days when both were very much more abundant than they are now.

In view of the favorable showing that has been made for this seal, both in the present study of its food habits and in the less extensive research formerly reported in the Journal, it would seem that the animal should be given respite from persecution until its economic status can be more fully determined. Thousands upon thousands of harbor seals have been destroyed in the bays and coastal waters of the Pacific Northwest in the present decade, as reported year after year by the bounty claimants. Other thousands were not so reported because they could not be secured for taking the scalp, upon which a price varying from two to ten dollars has been placed by state laws.

In this warfare on the harbor seal little use has ever been made of the animals so ruthlessly slaughtered. Skins, many of which are really beautiful and valuable for the making of sport garments, go over the side of the boat along with a carcass rich in oil. In the North Atlantic other species of seals are hunted extensively for just these products.

In any event, the numbers of the harbor seal on our Northwest Coast have now been so nearly reduced to the vanishing point that there should

TABLE I

Analyses of stomach contents of 100 harbor seals (*Phoca richardii*) taken in Puget Sound and in the coastal waters of Washington, December, 1927, to August, 1930.* The serial numbers are those of the Division of Food Habits Research, Bureau of Biological Survey.

No. 4224,	♀	Off mouth Nisqually River; 5 p.m., December 11; Weight 49 lbs. Stomach contents (¼ pint); remains of a small shiner = trace; beaks and pens of nine small and two large squids = 100%.
No. 4225,	♀	Off mouth Nisqually River; 9 a.m., December 20; Weight 41 lbs. Stomach contents (½ pint); two pollack and four shiners = 10%; squids, seven almost entire and beaks of six others = 90%.
No. 4526,	♀	Off mouth Nisqually River; 9 a.m., December 20; weight 50 lbs. Stomach contents (3 pints): 160 sand launce and 31 small tom-cod = 75%; seven squids = 25%; fragments of a small crab = trace.
No. 4227,	♂	Off mouth Nisqually River; 1 p.m., January 6; weight 94 lbs. Stomach contents (1½ pints): one tom-cod, a few bones of pollack and at least seven hake.
No. 4228,	♀	Off mouth Nisqually River; 3 p.m., January 6; weight 72 lbs. Stomach nearly empty. Beaks of two small squids.
No. 4229,	♂	Off mouth Nisqually River; 3 p.m., January 6; weight 195 lbs. Stomach empty.
No. 4230,	♂	Off mouth Nisqually River; 4 p.m., January 6; Weight 142 lbs. Stomach empty.
No. 4231,	♀	Off mouth Nisqually River; noon, January 7; Weight 85 lbs. Stomach empty.
No. 4232,	♂	Off mouth Nisqually River; 4 p.m., January 11; weight 70 lbs. Stomach contents (2 pints): remains of 11 hake.
No. 4233,	♀	Off mouth Nisqually River; 8 a.m., January 12. Weight 53 lbs. Stomach contents (2 pints): remains of five pollack, two small tom-cod and one singing fish or "Midshipman."
No. 4235,	♂	Off mouth Nisqually River; 9 a.m., January 12. Weight 194 lbs. Stomach empty.
No. 4236,	♂	Off mouth Nisqually River; 3 p.m., January 20. Weight 48 lbs. Stomach contents (3½ pints): four tom-cod, two herring, seven pollack and fourteen hake, largest about 10 or 12 inches long = 100%; 1 small squid = trace.
No. 4237,	♂	Off mouth Nisqually River; 8 a.m., January 22. Weight 147 lbs. Stomach contents (½ pint): 1 tom-cod, 3 hake, 5 pollack and otoliths of several others, few bones and 10 pairs otoliths of the singing fish; and a few bones of a small sculpin = 100%; beaks of three small squids = trace.

* For the sake of brevity scientific names are used in this table only where necessary to insure correct interpretation. All common names with their attendant Latin names are associated together in the preceding text.

TABLE I—*Continued*

No. 4238, ♂	Off mouth Nisqually River; 3 p.m., January 22. Weight 139 lbs. Stomach nearly empty—two otoliths of hake (*Merluccius productus*).
No. 4239,	No record furnished for this seal. Stomach nearly empty; beak of a squid.
No. 4240, ♂	Off mouth Nisqually River; 2 p.m., February 4. Weight 191 lbs. Stomach contents (8 pints): 64 singing fish, 40 of them entire and ranging from five to ten inches in length = 100%; pens of four squids = trace.
No. 4241, ♂	Off mouth Nisqually River; 8 a.m., February 12. Weight 106 lbs. Stomach contents (4 pints): 2 tom-cod, 1 pollack and at least 11 hake, seven of them entire except for heads, and eight to ten inches in length = 100%; beak of a squid = trace.
No. 4242, ♂	Off mouth Nisqually River; 2 p.m., February 15. Weight 84 lbs. Stomach empty.
No. 4243, ♂	Off mouth Nisqually River; 2 p.m., February 19. Weight 195 lbs. Stomach contents (1½ pints): about 20 herring from five to six inches in length.
No. 4244, ♀	Off mouth Nisqually River; 8 a.m., February 26. Weight 86 lbs. Stomach nearly empty; remains of a squid.
No. 4245, ♂	Off mouth Nisqually River; 8 a.m., March 1. Weight 80 lbs. Stomach contents (½ pint): 7 hake = 90%; 1 squid = 10%.
No. 4246, ♂	Off mouth Nisqually River; 9 a.m., March 1. Weight 252 lbs. Stomach nearly empty: 7 otoliths of tom-cod.
No. 4247, ♂	Off mouth Nisqually River; 11 a.m., March 4. Weight 97 lbs. Stomach contents (½ pint): fish flakes and bones and 202 otoliths, mostly those of tom-cod with a few of pollack and hake.
No. 4248, ♂	Off mouth Nisqually River; 8 a.m., March 15. Weight 95 lbs. Stomach empty.
No. 4249, ♀	Off mouth Nisqually River; 8 a.m., March 15. Weight 151 lbs. Stomach nearly empty: claw of a hermit crab.
No. 4502, ♂	Off Orcas I.; 9 a.m., June 25. Length 74 inches. Stomach contents (4 pints): remains 7 rockfish, four of them practically entire except for heads, 2 cod and 1 small blue-cod.
No. 4503, ♀	Off Cypress I.; 8 a.m., June 30. Length 70 inches. Stomach contents (¾ pints): 33 sand launce, entire fish from 4½ to 5½ inches in length.
No. 4504, ♀	Sinclair I.; 4 a.m., June 30. Length 51 inches. Stomach contents (1 pint): remains of 5 rockfish and 1 great sculpin.
No. 4505, ♀	Sinclair I.; 5 a.m., June 30. Length 53 inches. Stomach contents (2 pints): 9 cod, remains of three at least 15 inches long and six smaller ones, and one blue-cod = 100%; fragments of hairy crab, black-clawed crab and flat-topped crab = trace.
No. 4506, ♂	Sucia I.; 8 a.m., July 5. Length 52 inches. Stomach contents (¼ pint): remains of several herring and one small Gadid = 98%; remains of a number of small shrimp = 2%.

TABLE I—*Continued*

No. 4507, ♀	Sucia I.; 11 a.m., July 5. Length 59 inches. Stomach contents (½ pint): remains of 12 herring and one small pollack = 96%; a number of small shrimp = 4%.
No. 4508, ♀	Sucia I.; 4 a.m., July 6. Length 53 inches. Stomach nearly empty: a few nearly digested bones of three small cod and fragments of a hairy crab.
No. 4509, ♀	Sucia I.; 5 a.m., July 6. Length 61 inches. Stomach empty.
No. 4510, ♂	Bellingham Bay; 7 p.m., July 6. Length 46 inches. Stomach nearly empty: three pairs of otoliths with a few other bones of three small cod.
No. 4511, ♀	Sinclair I.; 5 a.m., July 8. Length 72 inches. Stomach contents (2 pints); 1 octopus entire, the longest arms measuring 11½ inches and one inch in diameter; also the mandibles (beaks) of thirty-one additional octopuses.
No. 4512, ♀	Sinclair I.; 4 a.m., July 8. Length 43 inches. Stomach contents (½ pint): bones of 12 cod and an otolith of a hake = 97%; remains of a hermit crab and 2 prawn (*Pandalus danæ*) = 3%; also a few pebbles, a large caddis fly case (*Trichoptera*) and bits of wood and coral = trace.
No. 4513,	not sexed, Sucia I.; 5 a.m., July 10. Length 62 inches. Stomach contents (2 pints): 61 sand launce = 100%; beak of an octopus = trace.
No. 4514, ♀	Sucia I.; 5 a.m., July 10. Length 61 inches. Stomach contents (1¾ pints): remains of 4 rockfish and 1 blue-cod = 100%; trace of an octopus; also a small stone and a fragment of seaweed.
No. 4515, ♂	Near Bell Rock, 4 a.m., July 12. Length 71 inches. Stomach empty.
No. 4516, ♂	Near Bell Rock; 4 a.m., July 12. Length 69 inches. Stomach contents (1 pint): remains of two smooth sculpin and two great sculpin = 94%; 4 hair crabs and 1 shrimp (*Crago franciscorum*) = 6%; 1 snail (*Trichotropis*) = trace.
No. 4517, ♂	Near Bell Rock; 4 a.m., July 12. Length 61 inches. Stomach contents (¾ pint): remains of 4 large octopuses, arms ¾ inches in diameter, stomach of one intact and crammed with fragments of crabs and bones of small fish.
No. 4518, ♀	Bellingham Bay; 8 p.m., July 13. Length 63 inches. Stomach contents (1 pint): remains of 8 *Pleuronectidae*, including 5 *Parophrys vetulus* (?); 1 cod and 1 blue-cod = 100%; 6 small shrimp (*Crago franciscorum*) = trace.
No. 4519, ♂	Bellingham Bay; 9 a.m., July 17. Length 61 inches. Stomach contents (¼ pint): a few bones of a flounder and of a cod.
No. 4520, ♂	Skagit Bay; 8 p.m., July 16. Length 60 inches. Stomach contents (¼ pint): far digested remains of several small fish, probably Ammodytidae.
No. 4521, ♀	Skagit Bay; 5 a.m., July 16. Length 63 inches. Stomach contents (1 pint): remains of 19 hake, the majority eight to ten inches in length.

TABLE I—*Continued*

No. 4522, ♀ Port Susan; 5 a.m., July 31. Length 69 inches. Stomach contents (1 pint): remains of at least 7 singing fish, 1 pollack, 12 flounders (*Parophrys vetulus* (?)) and 3 hake = 100%; 7 shrimp (*Crago franciscorum*), and fragments of several small bivalve mollusks = trace.

No. 4523, ♀ Padilla Bay; noon, August 21. Length 70 inches. Stomach contents (½ pint): fragments of one shiner and several flounders including at least 2 *Parophrys vetulus* (?). Note: Food of fish was amphipods.

No. 4524, ♀ Sucia I.; 7 p.m., August 6. Length 62 inches. Stomach contents (1 pint): contained remains of three small flounders, 4 blue-cod and 1 Cottid = 99%; 5 small bivalves (*Yoldia myalis*) = 1%; fragments of a crab = trace.

No. 4525, ♀ Sucia I.; 3 p.m., August 7. Length 59 inches. Stomach contents (1½ pints): remains of 2 herring and 9 flounders = 100%; fragments of 2 small bivalves (*Yoldia myalis*) = trace.

No. 4526, ♀ Padilla Bay; 10 a.m., August 16. Length 61 inches. Stomach contents (1½ pints): remains of 5 smooth sculpin and 17 flounders, including *Parophrys vetulus* (?) = 100%; fragments of a mud crab = trace.

No. 4922, not sexed, Willapa Bay; a.m., June 1. Stomach contents (1 pint): remains of 5 small fish, including at least 3 flounders = 98%; 1 shrimp (*Crago stylirostris*) = 2%.

No. 4923, not sexed, Willapa Bay; a.m., June 2. Stomach contents (½ pint) remains of 1 blue-cod; 1 smooth sculpin and 4 herring = 65%; 13 shrimp (*Crago franciscorum*) = 35%.

No. 4924, not sexed, Willapa Bay; 11 a.m., June 13. Stomach empty.

No. 4925, not sexed, Willapa Bay; a.m., June 20. Stomach contents (1½ pint): 1 tom-cod, 2 great sculpin, 3 smooth sculpin and 14 flounders = 70%; 3 western lamprey (*Entosphenus tridentatus*) = 30%; 1 small mud crab and 1 shrimp (*Crago* sp.) = trace; also algae, hydroids etc., 2 per cent of the gross contents of the stomach.

No. 4926, not sexed, Willapa Bay; a.m., June 20. Stomach contents (1 pint): at least 2 western lamprey (*Entosphenus tridentatus*) = 40%; 1 fish twelve inches long without the head (Clupeidae) = 60%.

No. 4927, not sexed, Willapa Bay; a.m., June 20. Stomach contents (1 pint): 1 pair of Pleuronectid otoliths, bones of at least 12 tom-cod and otoliths of 62 others = 98%; 4 shrimp (*Crago stylirostris*) and 16 small edible crabs = 2%.

No. 4928, not sexed, Willapa Bay; p.m., June 25. Stomach contents (¼ pint): 4 smooth sculpin = 88%; 1 shrimp (*Crago stylirostris*) and fragments of a porcelain crab = 12%. Debris (algae and hydroids) 12% of the contents.

No. 4929, not sexed, Willapa Bay; July 21. Stomach contents (1 pint): bones of 1 seven-inch smooth sculpin and 1 blue-cod fourteen inches long without head.

TABLE I—*Continued*

No. 4930, not sexed, Willapa Bay; July 23. Stomach contents (1 pint): remains of 16 smooth sculpin and 1 flounder = 82%; 4 burrowing crayfish. (2 *Upogebia pugettensis* and 2 *Callianassa californiensis*), and one edible crab = 18%. Debris (algae and hydroids) 10% of the gross contents.

No. 4931, not sexed, Willapa Bay; August 1. Stomach contents (4½ pints): 24 tom-cod, several small herring and 19 flounders = 100%. Three small hairy crabs = trace.

No. 4932, not sexed, Willapa Bay; August 14. Stomach contents (5½ pints); 37 smooth sculpin, 5 flounders, 14 blue-cod, 1 sculpin (Cottidae), several herring and 2 blenny (*Lumpenus gracilis*) = 98%. Six shrimp (*Crago stylirostris*) and 4 burrowing crayfish (2 *Upogebia pugettensis* and 2 *Callianassa californiensis*) = 2%. Debris (algae and hydroids) 6% of the gross contents.

No. 4933, not sexed, Willapa Bay; August 14. Stomach contents (6½ pints): bones of 47 tom-cod and otoliths of 23 others, 2 blue-cod, 3 flounders and 7 smooth sculpin = 98%; 27 shrimp (*Crago stylirostris*) and 1 crab = 2%.

No. 4934, not sexed, Willapa Bay; August 18. Stomach contents (2 pints): bones and flesh of 9 tom-cod and otoliths of at least 20 others, 1 small flounder, 1 herring and 9 smooth sculpin, four to seven inches in length = 100%; 8 shrimp (*Crago stylirostris*) and 11 mollusk egg cases = trace.

No. 4935, not sexed, Willapa Bay; August 18. Stomach contents (2½ pints): bones and flesh of 40 tom-cod and otoliths of 55 others = 100%; 9 shrimp (*Crago stylirostris*) and 3 small hairy crabs = trace.

No. 4936, not sexed, Sinclair I. (Puget Sound); 4 p.m., July 14. Stomach contents (¼ pint): remains of several small herring.

No. 5195, not sexed, Padilla Bay (Puget Sound); 7 a.m., August 31. Stomach contents (2 pints): 39 blenny (*Lumpenus gracilis*) and 1 smooth sculpin.

No. 4938, not sexed, Skagit Bay; 7 p.m., July 18. Stomach empty.

No. 4939, not sexed, Skagit Bay; 8 p.m., July 18. Stomach contents (¼ pint): remains of 1 hake, 1 flounder and 1 blenny (*Lumpenus gracilis*).

No. 4940, not sexed, Padilla Bay; 7 p.m., July 30. Stomach contents (1¼ pints): 16 blenny (*Lumpenus gracilis*).

No. 4941, not sexed, Skagit Bay; 9 a.m., August 1. Stomach contents (¼ pint): remains of 10 smooth sculpin = 100%; 2 shrimp (*Crago franciscorum*), 4 Isopods (Idotheidae) = trace.

No. 4942, not sexed, Port Susan; 3 p.m., August 2. Stomach contents: (¼ pint): 1 flounder (bones and flakes).

No. 4943, not sexed, Port Susan; August 1. Stomach contents: (1¼ pints): remains of two large flounders.

No. 4944, not sexed, Port Susan; 4 p.m., August 1. Stomach contents (¼ pint): 6 four-to six-inch flounders.

TABLE I—*Continued*

No. 4945, not sexed, Bellingham Bay; 1 p.m., August 5. Stomach contents (½ pint): remains of a flounder and 5 blenny (*Lumpenus gracilis*); fragments of burrowing crayfish (*Upogebia pugettensis*) = 2%.

No. 4946, not sexed, Port Susan; 9 a.m., August 17. Stomach contents (½ pint): remains of 4 hake.

No. 5170, ♀ Off mouth Nisqually River; 9 a.m., Sept. 2. Weight 103 lbs. Stomach contents (½ pint): 3 shiners.

No. 5171, ♂ Off mouth Nisqually River; 3 p.m., Dec. 4. Weight 53 lbs. Stomach contents (4 pints): 64 tom-cod, 1 hake, 18 shiners, and 4 herring = 100%; 1 small squid = trace.

No. 5172, ♂ Off mouth Nisqually River; noon, Dec. 31. Weight 109 lbs. Stomach contents (5 pints): at least 21 herring.

No. 5173, ♂ Off mouth Nisqually River; 3 p.m., Feb. 3. Weight 173 lbs. Stomach contents (4 pints): remains of a salmon (*Oncorhyncus* sp.) twelve to fourteen inches long = 12%; 4 singing fish, 3 shiners, 5 tom-cod and 8 herring = 64%; 44 squids = 24%.

No. 5174, ♀ Off mouth Nisqually River; 4 p.m., Feb. 3. Weight 85 lbs. Stomach contents (1 pint): 4 tom-cod, 1 hake, 4 shiners, 1 pollack and 2 small rockfish = 100%; pen and beak of a squid = trace.

No. 5175, ♂ Off mouth Nisqually River; 2 p.m., Feb. 14. Weight 246 lbs. Stomach nearly empty: a few fish vertebrae (not Salmonidae).

No. 5176, ♀ Off mouth Nisqually River; 11 a.m., March 20. Weight 50 lbs. Stomach contents (½ pint): flakes and bones of 4 herring = 100%; beaks of 2 squids = trace.

No. 5177, ♀ Off mouth Nisqually River; 1 p.m., March 28. Weight 114 lbs. Stomach contents (¾ pint): remains of several herring and 5 smooth sculpin.

No. 5178, ♂ Off mouth Nisqually River; 1 p.m., March 29. Weight 216 lbs. Stomach contents (½ pint): remains of 1 large cod, otoliths of 2 tom-cod and 6 hake.

No. 5179, ♀ Off mouth Nisqually River; 10 a.m., March 28. Weight 72 lbs. Stomach contents (3 pints): 16 herring and 1 shiner.

No. 5180, ♀ Off mouth Nisqually River; 7 p.m., April 20. Weight 157 lbs. Stomach contents (6 pints): 62 singing fish six to eight inches in length, most of them more or less entire.

No. 5181, ♀ Off mouth Nisqually River; 1 p.m., May 4. Weight 151 lbs. Stomach contents (3 pints): remains of 15 Pacific porgy, 1 rockfish and 1 otolith of a tom-cod.

No. 5182, ♀ Off Nisqually River; 2 p.m., May 12. Weight 123 lbs. Stomach contents (1 pint): 4 herring and 2 tom-cod.

No. 5183, ♂ Off mouth Nisqually River; 2 p.m., May 13. Weight 67 lbs. Stomach contents (6 pints): 27 herring.

No. 5184, ♀ Off mouth Nisqually River; 3 p.m., May 13. Weight 149 lbs. Stomach contents: (2 pints): 14 tom-cod and 2 flounders = 100%; 2 crabs (1 *Cancer gracilis* and 1 *Pinnixia schmitti*) = trace.

TABLE I—*Concluded*

No. 5185, ♀	Off mouth Nisqually River; 3 p.m., May 13. Weight 165 lbs. Stomach contents (2 pints): a 21-inch ratfish.
No. 5186, ♂	Off mouth Nisqually River; 2 p.m., May 26. Weight 185 lbs. Stomach contents (6 pints): 2 large cod.
No. 5187, ♀	Off mouth Nisqually River; 9 a.m., June 19. Weight 197 lbs. Stomach contents (1 pint): 8 herring.
No. 5188, ♀	Off mouth Nisqually River; 7 a.m., June 25. Weight 97 lbs. Stomach contents (½ pint): 45 shiners.
No. 5189, ♀	Off mouth Nisqually River; 10 a.m., July 3. Weight 169 lbs. Stomach contents (½ pint): 23 herring.
No. 5190, ♀	Off mouth Nisqually River; 2 p.m., July 8. Weight 207 lbs. Stomach contents (½ pint): 13 flounders (otoliths of 32), remains of 28 tom-cod and 3 hake.
No. 5191, ♀	Off mouth Nisqually River, 8 a.m., July 9. Weight 60 lbs. Stomach contents (2½ pints): 22 flounders, including *Hippoglossoides elassodon*, 2 of them entire, six inches and fourteen inches long, respectively.
No. 5192, ♀	Off mouth Nisqually River, 11 a.m., July 20. Weight 178 lbs. Stomach contents (1 pint): 56 herring.
No. 5193, ♂	Columbia River near Svensen, Ore., July. Stomach contents (2½ pints): parts of a large fat salmon (*Oncorhyncus sp.*), ventral fins, flesh, and a few bones.
No. 5194, ♀	Port Susan; 10 a.m., August 17. Stomach contents (1½ pints): remains of 13 hake.

be no good reason for continuing the payment of bounties. With the seal, as with certain other mammals and birds, it is the individual or small groups of individuals that in time and place become troublesome and may then be properly dealt with as the occasion may require.

The following pages present a study of the food habits of the harbor seal based on the laboratory examinations of 100 stomachs. These seals (collected December, 1927 to August, 1930) were all taken in the semi-inclosed or coastal waters of Washington and represent each month of the year except October[1] and November, although only single stomachs were available taken in April and September. Ten of the stomachs were empty or contained only parasitic worms; nine others held mere traces of food. Thus the results of the detailed examination of 81 stomachs were available for the present report.

[1] Nine October stomachs of *Phoca richardii* were included among the 35 examined for a previous report (Journal of Mammalogy, vol. 9, No. 1, February, 1928) and notes comparing their contents with those of the present series are included in the present article.

Most fishes can be identified from skeletal parts as found in the stomachs but the percentages by bulk that should be given of the various kinds, when several are present in one stomach, can rarely be safely estimated, although such data often would be highly desirable. However, when fish and other items of food, such as shrimps, crabs, squids, etc., are mixed together in the same stomach they can readily be separated and measured.

FISHES (93.58 PER CENT)

Fish were found in all but two of the eighty-one seal stomachs and averaged more than nine-tenths of the contents. The cod family (Gadidae) occupy first place on the seal's menu chiefly because of the tom-cod (*Microgadus proximus*), which was eaten by twenty-two individuals, high counts of tom-cods for single stomachs being 40, 47 and 64. The ear bones (otoliths) of 200 tom-cods were found in one stomach collected in March, being, of course, the accumulations of the more indigestible parts of several meals. Other gadids identified were the pollack (*Theragra fucensis*) and cod (*Gadus macrocephalus*), present in ten and nine stomachs, respectively.

Flounders (Pleuronectidae-broad sense) were found in 23 stomachs, all taken during May, June, July and August. If September and October stomachs had been available for study they likewise probably would have contained flounders, for one of the seals collected in October, 1926, had eaten seven of these peculiar, asymmetrical fishes. Most of the flounders captured by the seals were quite small, six inches or less in total length, although one, identified as *Hippoglossoides elassodon*, was fourteen inches long. High counts of flounders in individual seal stomachs were 17, 19 and 22.

Pacific herring (*Clupea pallasii*) seem to be a favorite seal food, for they are eaten in quantity throughout the year. The greatest number identified in any one stomach was 56, but counts of 20 or more were recorded from 6 stomachs.

Hake (*Merluccius productus*) were identified in 18 stomachs, but had not been eaten by seals collected during May and June, although represented in one of the June, 1926, stomachs. High counts of hake were 13, 14 and 19.

Sculpins (Cottidae) are an important summer food of the seal, as all but one of the 17 records occurred in June, July and August. Two species were identified, namely, the smooth sculpin (*Leptocottus armatus*) and the great sculpin (*Myoxocephalus polycanthocephalus*), the former being found in 13 stomachs in numbers as great as 10, 16 and 37.

The ling or blue cod (*Ophiodon elongatus*) was taken three times each in the months of June, July and August, high counts being 2, 4, and 14.

Surf fishes (Embiotocidae) occupy sixth place in the fish diet of the harbor seal, chiefly because shiners (*Cymatogaster aggregatus*) proved to be available and acceptable at all seasons. Eleven seals had eaten these little fishes, one June specimen devouring 45 and another taken in December capturing 18.

In this study the pile perch or Pacific porgy (*Damalicthys argyrosomus*) was included on the seal's menu on the basis of 15 specimens found in the stomach of a large female seal collected in May. However, in a previous study (1926 collec-

tion), one seal stomach taken in October was found to contain 9 pile perch as well as 10 shiners.

The singing fish or midshipman (*Poricthys notatus*) and a blenny (*Lumpenus gracilis*) were each recorded from six stomachs. The midshipman, however, must be considered the more important food, for three additional records of it were made in the 1926 series of seal stomachs. Furthermore, high stomach counts of *Poricthys* were 62 and 64 compared with 16 and 39 for *Lumpenus*.

Rockfish (*Sebastodes*) helped to make up the last meals of five seals, two collected in June, and one each in February, May and July.

Sand launces (*Ammodytes personatus*) were eaten by only four seals but in three cases the number of individual captures was large, namely, 33, 61, and 160.

Western lampreys (*Entosphenus tridentatus*) composed 30 and 40 per cent respectively of the food of two seals collected in June.

Salmon (*Oncorhyncus*) were found in only two of the 100 seal stomachs; one was taken in the Columbia River late in July and the other off the mouth of the Nisqually River in February. The latter contained four singing fish, three shiners, eight Pacific herring, five tom-cod and 44 squids in addition to the salmon, which was a specimen about 12 to 14 inches in length and comprised 12 per cent of the contents.

One seal collected in May had eaten a 21 inch ratfish (*Hydrolagus colliei*).

Unidentified fish remains (not Salmonidae) were present in two seal stomachs.

MOLLUSCA (5.82 PER CENT)

The abundance of squids in Puget Sound during the winter season is shown by finding them in 18 of the 21 seal stomachs collected between December and March. This indicates a definite seasonal squid migration, for the commercial squid season on the California coast (Monterey and southward) is April, May and June, and not a single squid was found in the 60 seal stomachs collected in Puget Sound and coastal Washington waters during the April to September period.

That the octopus (*Polypus hongkongensis*) may have a seasonal movement complementary to that of the squid in Washington waters is suggested by the nature of their occurrence in the harbor seal's menu. They were present in four of the 23 stomachs collected in July, formed 8.7 per cent of the seals' food for that month, and were not eaten at any other time of year. In two cases octopus remains were the only food present, although the stomachs were well filled. One of these held the remains of four octopuses, while the other contained one octopus entire (longest arms being 11½ inches) and the mandibles of 31 others.

Other molluscan remains found in the seal stomachs were a snail (*Trichotropis*) with one record, and a bivalve (*Yoldia myalis*) with two records; in each case, however, they composed only a trace of the total contents and probably were taken incidentally to the capture of other food.

CRUSTACEA (0.6 PER CENT)

Crustacea, chiefly shrimps and crabs, supplied scarcely more than one-half of one per cent of the seals' total food, although contributing two per cent of the menu during June, July and August. Shrimps (*Crago franciscorum* and *C. stylirostris*) were most prominent and occurred in fourteen stomachs. The high shrimp count in the present stomach series was 27, but one of the seals collected

in October, 1926, had eaten 148 *Crago franciscorum*. Other crustaceans identified among the stomach contents of the harbor seal include: hairy crab (*Cancer oregonensis*) and edible crab (*C. magister*) as well as the related *Cancer gracilis;* mud crab (*Hemigrapsus oregonensis*), hermit crab (*Pagurus*), porcelain crab (*Petrolistes cinctipes*), and flat-topped crab (*P. eriomerus*); the prawn (*Pandalus danae*), "ghost shrimps" or burrowing crayfish (*Callianassa californiensis* and *Upogebia pugettensis*), and *Pinnixa schmitti*.

No doubt many of these small crustaceans entered the seal stomachs as secondary food. Certainly the presence of some of them is thus explained, for the examination of some of the intact stomachs of the fish victims of the seals revealed amphipods, isopods and shrimps, while the stomach of an octopus was filled with the remains of small fish and crabs.

CAPACITY OF THE SEAL'S STOMACH

The largest meal recorded for one seal was eight pints (six pounds) and consisted of 64 singing fish, 40 of them entire and ranging from five to ten inches in length. Several seals had consumed six pints of food but the average for 81 stomachs was 1.75 pints. The best filled stomachs were collected in February (five stomachs) and May (six stomachs), when the stomach contents averaged 3.7 and 3.33 pints, respectively.

PARASITIC WORMS

Parasitic round worms (*Porrocaecum decipiens*), varying in numbers from a few to several hundred, were present in all but 16 of the 100 seal stomachs. Eleven (approximately 70 per cent) of the worm-free stomachs were among the 47 collected during May, June and July. It is of interest to note also that only one of the 21 seals examined in 1926 (suckling young not included) was free from stomach worms, and it was collected in May.

Stomach worms of the harbor seal, like those of most mammals, do not directly injure the living tissues and probably cause no appreciable discomfort to the host except when the stomach is empty of food. When the stomach is more or less filled with food the worms seem to concentrate on the outer surface of the food mass next to the stomach walls. However, as digestion progresses their activity in the stomach is indicated by the manner in which they thread their bodies through the food, even penetrating small passages in the fish bones.

SUMMARY

Analyses of the contents of 100 stomachs of the harbor seal (*Phoca richardii*) were made in the laboratory. Ten per cent were found to be empty and nine per cent contained only traces of food.

Fish comprised 93.58 per cent of the food. The chief species were tom-cod, flounders, Pacific herring, hake, sculpins, cod, blue-cod, pollack, and shiners. Salmon were found in only two stomachs.

Squids were eaten in winter and octopuses in summer, the two composing 5.82 per cent of the food.

Crustacea made up less than one per cent of the stomach contents. Shrimps were occasionally taken in quantity. The smaller forms no doubt were derived from fishes, octopuses, or squids, preyed upon by the seals.

The average food content of the stomachs was found to be 1.75 pints; the largest meal recorded was 8 pints.

Parasitic round worms were present in 84 of the 100 stomachs. The majority of worm-free stomachs were collected during May, June and July.

U. S. Biological Survey, Washington, D. C.

NOTES ON THE LIFE HISTORY OF THE RED TREE MOUSE, PHENACOMYS LONGICAUDUS

By Seth B. Benson and Adrey E. Borell

During the past winter it was our good fortune to become acquainted with the red tree mouse, and in studying it we were able to ascertain some facts concerning its life history which in some respects amplify or modify the accounts of this species by W. P. Taylor (1915) and A. B. Howell (1926).

We had our first opportunity to study this mouse while on a trip into Humboldt County, California, in company with Dr. Jean M. Linsdale and Mr. Ralph Ellis, Jr. On November 28, 1930, a nest of a red tree mouse was found in a Douglas fir two miles south of Kneeland Post Office. The mouse was not seen and no search was made for other nests at this place. We spent the evening of November 28 and the morning of the next day at the home of Mr. H. E. Wilder of Carlotta. Mr. Wilder showed us the nests of tree mice around his home, allowed us to capture several mice and to retain one as a specimen, and told us a great deal about their habits. He said that the mice were less common than they were when Howell studied them there because of collecting and the logging of the hillside surrounding his home. In the afternoon, armed with this information, we traveled up the Van Duzen River and examined two colonies beside the highway near Bridgeville, one about one mile west, the other two miles east of that place. We collected twelve mice in the space of two hours. These mice, except for one found dead, were transported alive to Berkeley.

We next found tree mice December 13 and 14 in the Bohemian Grove on the Russian River near Monte Rio in Sonoma County. Nests were not abundant here, but three mice were driven from nests and two of them captured. We also found nests and captured one mouse along the highway one mile north of Camp Meeker, Sonoma County.

On February 1, 1931, a trip was made to the vicinity of Camp Meeker in order to obtain more living mice. A male was secured one mile north

of Camp Meeker, and a female and a half grown young were captured one-half mile south of Occidental, Sonoma County.

Two trips were made into the Santa Cruz Mountains and one trip was made to Marin County in an effort to find tree mice in suitable places there, but without success.

Since our observations agree in the main with the accounts by Taylor and Howell, only those observations which are additional to them, or do not entirely agree with them, are given in the following account. Altogether we examined about seventy nests and captured or observed twenty-three mice.

NESTS

The only rule we can give as to the position of the nest is that it is placed anywhere there is a sufficiently firm support in close proximity to a supply of green leaves of Douglas fir (*Pseudotsuga taxifolia*) or grand fir (*Abies grandis*). Such places are naturally most commonly found within these trees. Thus in small trees the nests are usually placed near the top against the trunk, and in large trees with large branches, well out on top of the branches among the living twigs. Some of these nests may be as far as thirty feet from the trunk of the tree. One nest observed two miles east of Bridgeville was placed twenty feet from the ground between two small firs at a point where two small branches, crossing at right angles, made a fairly secure foundation.

In the colonies near Bridgeville the majority of the nests had been constructed entirely by the mice. Several contained mud balls and so perhaps had been constructed on top of old robins' nests, while one was built in an old squirrel's nest. All the nests observed near Bridgeville were placed in Douglas firs or grand firs.

In the Bohemian Grove most of the nests were found in Douglas firs, but one very large nest, containing a large male, was found in a small redwood tree (*Sequoia sempervirens*) which was in close proximity to a fir tree.

The most peculiar nest was one found one mile north of Camp Meeker and was inhabited by a male. The nest was thirty feet up in a small redwood tree, one of a group of four surrounding a stump. The nest was composed of a loose platform of dead redwood twigs with a large pile of freshly cut redwood and fir twigs placed on top of it. In an adjacent fir tree there was another platform built of the same material, but this pile was uninhabited. We thought at first that the latter platform had been built by a gray squirrel (*Sciurus griseus*), since squirrels were common in the vicinity, even though the platform was unlike any of the gray squirrel nests we had examined. But when we found that the other nest, of similar construction, contained a tree mouse, we concluded that tree mice had built both platforms. At least the tree mice must have brought the short, freshly cut twigs to the platforms. The inhabited nest contained a very small amount of the refuse of the Douglas fir needles which the mouse had eaten. None of the redwood needles had been eaten. Evidently the mouse had just taken up his abode in the tree. A rain that fell a few days previously may have driven the mouse out of a burrow in the ground.

We could distinguish no difference in the construction, size, or placement of the nests of males and females. The largest and best constructed nest observed was occupied by a large male.

YOUNG

Our observations support the view that breeding takes place throughout the year. A female and two small young were secured two miles east of Bridgeville on November 29. The young did not have their eyes open and they were covered with a short growth of reddish hair. They lived almost a week in captivity, but died because the mother neglected them. A female and two half-grown young were routed on February 1 from a nest one-half mile south of Occidental. One of the young fell to the ground and was lost. The next day the other young mouse weighed 13.2 grams as compared with the 28.8 grams of the mother. This young mouse must have been at least a month old, as the average weight at thirty days of two mice raised in captivity by Howell was only 11.35 grams. Yet this mouse still nursed. It ate freely of fir needles, but the persistence with which it attempted to suckle its mother indicated that it obtained some nourishment from her. The young one would turn on its back to force its way beneath the mother as she sat feeding and would lie there attached to a nipple for minutes at a time. The mother did not object to the procedure. At times she would facilitate the efforts of the young mouse to get beneath her. On one occasion, after the young mouse had been without food and alone during a part of one night, it ate fir needles with avidity on being returned to the cage with its mother. It did not take nourishment from the mother until after it had its fill of fir needles although she was most solicitous of its welfare, licking the young one's hair and exhibiting other signs of interest.

This female was found to contain three small embryos on February 5, showing that litters may follow one another rather closely. None of the seven other females taken was pregnant.

FOOD

Our observation of the manner in which the red tree mouse eats fir needles leads us to differ from Howell's interpretation. According to Howell (1926, p. 51) the mouse eats each side, including the lateral resin duct, and discards the medullary portion, the "midrib." Taylor (1915, p. 142) had previously stated that the sides of the needles, including the resin ducts, were split off and discarded while the remainder of the leaf, including the medullary portion, was consumed. Our observations agree with Taylor's description.

This manner of feeding was noticed at once while we were first watching the animals in the laboratory. Close observation of the ten adults then in captivity, including one from Carlotta and nine from near Bridgeville, showed that they all used the same method most of the time. The specimens from the Bohemian Grove, near Camp Meeker, and from Occidental were also observed to eat in the same manner, showing that the habit is widespread geographically. The second trip to Camp Meeker was made expressly to check this observation. Even the baby mouse captured on this trip used the method described below when eating large needles.

One male from two miles east of Bridgeville varied so little in his manner of

eating that it was almost machine-like. He would bite a needle from a twig, then, holding it in both hands and beginning near the base, would split off the outer side of the needle, running the needle from right to left. The outer portion would usually fall off or be pulled off, but frequently would remain attached at the base. Then the needle would be reversed end for end and turned over, and, beginning at the apex and running the needle from right to left as before, the mouse would split off the other resin duct which would usually remain lightly attached at the base. Then holding the remainder of the needle in the left hand the mouse would eat it as one would eat a stalk of celery. As this mouse was quite tame the whole process could be followed by observing the animal at close range and by taking needles away from it at various stages in the process. The mouse was always reluctant to let go of the needle when it was seized by a pair of forceps and was often successful in jerking the needle free. The mouse would temporarily appear at a loss when a needle was taken away from it, as if not accustomed to having the feeding rhythm broken in this manner.

Although the mice ate in this manner most of the time there was some variation, especially in certain individuals. Sometimes only one side of a needle would be stripped off; sometimes a needle would be split down the middle and both portions consumed; or needles, especially when small, were eaten entire. But we never observed any mouse eat the resin ducts and discard the medullary portion of the needle.

The material discarded by the mice in feeding which, as shown above, was known to be composed of the outer edges of the needles, proved to be identical with the material making up the nests found in the field. Mr. Herbert L. Mason of the Department of Botany of the University of California kindly checked our determinations and agreed with them. He suggested that the presence of resin in the ducts might account for their being discarded, and stated that there was no substance in the medullary portion of the needle so likely to be too distasteful for the mice to eat. The fact that small young needles, in which the resin ducts are not fully formed, are often eaten entire is in consonance with his suggestion.

An examination of nest material which had been collected by Taylor in 1913 and preserved in the Museum of Vertebrate Zoology showed that it was composed of discarded resin ducts as Taylor has stated. Material from dozens of old and new nests in the Bohemian Grove, near Camp Meeker, and at Occidental were carefully examined in the field to check our laboratory observations. In all cases the nests were composed of resin ducts and the tissues surrounding them. Identification is easy even to the naked eye because one side of the filament, the former edge of the needle, is always smooth and rounded, and only one side shows the marks of teeth. A "midrib" could not exhibit such a structure.

Miss Lucile Roush and Miss Alice Handschiegl of the Department of Botany very kindly aided in the preparation of cross-sections of entire Douglas fir needles and of the portions discarded by the mice. Mrs. Frieda L. Abernathy made the accompanying drawings of the cross-sections and of a series of needles showing the results of the trimming process.

In contrast with Howell's results as to the food eaten by *Phenacomys longicaudus*, we found that the mice ate freely of many substances other than fir needles. Captive mice, although furnished with a constant supply of fresh twigs of Douglas fir and grand fir, would eat freely of rolled oats, fresh apples, fresh

carrots, fresh squirrel meat, dried pears, dried apples, raisins, leaves of the deodar (*Cedrus deodara*), and bristle-cone fir (*Abies venusta*). They stored the surplus in the nests and other secluded places about their cages. One mouse was observed to eat green grass that was ignored by most of the captives. However, the fir needles formed the bulk of their food and when they were withheld the animals died. One died after six hours although rolled oats, which it had eaten previously, and leaves of the California nutmeg (*Tumion californicum*) were available. Another died after thirty-six hours although redwood twigs, rolled oats, fresh and dried apples, and raisins were supplied. It ate some of the redwood needles before it died. These experiments are not at all conclusive and, in view of the fact that the mice ate freely of other food, it might be that tree mice can exist for considerable periods without fir needles. But it cannot be denied that fir needles are their main diet.

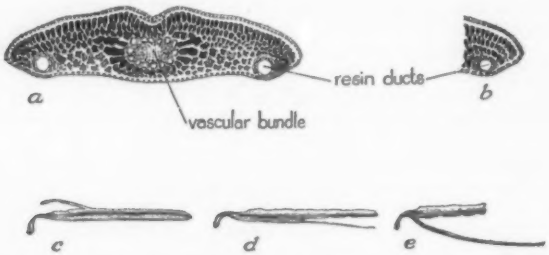

FIG. 1. NEEDLES OF DOUGLAS FIR (PSEUDOTSUGA TAXIFOLIA)

a, cross section, ×30; *b*, cross section of portion discarded by red tree mouse, ×30; *c* and *d*, superior view showing successive stages in the trimming process, ×1; *e*, superior view showing needle trimmed and half consumed, ×1.

The mice drank water frequently while in captivity. The half-grown young mouse from Occidental met its death by drinking water. A tube filled with water was offered to it and the mouse, after sniffing at the water curiously, attempted to drink, but choked and snuffled as if the water had gotten into the wrong passage. This was not considered a serious matter at the time; but several hours later the mouse was found at the point of death, breathing spasmodically and with difficulty. It soon died and was dissected immediately. The oesophagus, stomach, and small intestine were found to be filled with a clear liquid, presumably water, and bubbles of air. A part of the stomach, the posterior part of the small intestine and the caecum contained food so that the mouse could not have starved. It must have choked on the water.

HABITS

In our limited experience we did not observe the differences in number and behavior supposed to exist between the sexes. The sexes were equally represented in the sixteen adult and subadult mice which we collected. As already

noted above, there appeared to be no difference in the type of nest occupied by the two sexes.

Males and females are supposed not to inhabit the same nest, but we found an adult male and a subadult female in the same nest two miles east of Bridgeville.

We also found that more than one mouse may live in the same tree. In a large Douglas fir one mile west of Bridgeville, which bore large living branches clear to its base, four fresh nests were found. Mice were found in three of them and driven to the ground. Two were captured, a male and a female. These results verify Howell's supposition that a large tree may contain several inhabited nests.

OTHER BEHAVIOR

We found that it was easy to keep the mice alive in captivity if they were given plenty of room, shelter, food, and freedom from disturbance. Most of them were phlegmatic and easily adjusted themselves to captivity, but there was considerable individual difference in their temperaments. They could be handled with ease, for they seldom attempted to bite or to escape. However, if the conditions were not quite right, the mice weakened and died. The more nervous individuals died first.

Six mice, one from Carlotta and five from near Bridgeville, were kept in a bathtub containing a layer of sawdust. They had a nest box filled with cotton in which they spent most of the time. The room in which they were kept was cool and the mice were disturbed but little. A constant supply of Douglas fir twigs was kept in the tub. The mice did not seem to be much disturbed by the unnatural conditions of their abode. Contrary to Howell's statement they seemed to prefer the cotton as material for the nest. They moved the nest several times, once from the box into a tangle of branches, and then back into the box again. All six of them slept in the same nest most of the time. After four days four of them were removed and made into study skins. The two survivors were kept a month longer before they, too, were killed. The two survivors, a small male and an adult female, lived together in perfect amity, occupying the same nest most of the time.

Four other adults and the two young mice were kept in small cages in a room which was quite warm and in which the mice were frequently disturbed. They did not thrive so well here. The young mice died six days after capture because the mother was too restless to care for them. The mother died three days later.

A male, one of the pair found together, was very weak one morning, because of an insufficient supply of food during the night. The mouse was too weak to eat when food was available and soon died. The female captured at the Bohemian Grove was wild in contrast with most of the other mice. She was etherized after she had become weak because of a refusal to eat. The single survivor, a small female, seemed not to be affected by the adverse conditions, but was thriving until deprived of fir needles in the course of a feeding experiment mentioned above.

Later a female and a half-grown young one were kept in this room. The young one choked itself on water and the female starved a few days later refusing to eat dry needles. All the mice in the warm room drank a great deal of water in contrast with the mice kept in the colder room.

PARASITES AND DISEASE

We found several of the mice to be infested with small mites which were identified by Mr. H. E. Ewing of the Bureau of Entomology, United States Department of Agriculture, as *Atricholaelaps californicus* (Ewing). Another had a heavy conjunctival infestation of nematodes. These were identified by Mr. O. L. Williams of the Department of Zoology, University of California, as "very young larval nematodes, apparently of the Order Filaroidea." One mile west of Bridgeville a mouse was found lying dead in the top of a bush. The mouse had probably died from some disease and had fallen from the trees above. There were large naked areas on its head and belly, the pelage was rough and the skin scurfy, as if the mouse had been attacked by a mange. Another male captured alive in the same locality suffered from a similar disorder that kept the hair from growing normally. This mouse thrived until December 22, when it was killed.

At the Bohemian Grove a nest was found to contain a salamander (*Aneides lugubris lugubris*) as well as a tree mouse. Near Camp Meeker, a nest was found to contain a large black salamander which was lost when thrown to the ground. It may have been *Aneides flavipunctatus*. Near Occidental an abandoned nest sixty feet up in a slender Douglas fir was found to contain a small *Aneides lugubris lugubris*. Since salamanders of this genus are known to be partly arboreal it is not at all surprising to find them in the damp nests of the red tree mouse.

DISTRIBUTIONAL FACTORS

We found the tree mice most commonly in the smaller Douglas firs or in large ones which bore living branches down close to their bases. Near Bridgeville the mice appeared to be colonial because here there were many such trees along the borders of pure stands of Douglas firs. In the Bohemian Grove, near Camp Meeker and at Occidental the nests were scattered because the Douglas firs were scattered. On the hillside west of Occidental we found tree mouse nests, mostly old ones, in nearly every suitable tree even though these trees were sometimes rather widely separated from one another. This indicates that tree mice wander about on the ground more than is generally supposed. We believe that the tendency for tree mice to build nests in the smaller trees, or in trees with many branches toward their bases, may perhaps be explained as follows: First, the habit that the mice have of leaping to the ground when disturbed would be too dangerous to them were they to leap from tall trees having no branches to break their fall. Second, the mice would be too much exposed to attack by enemies when climbing the bare trunks of tall trees.

We did not observe nests in tall trees such as occur in the midst of pure stands; but this may have been due, as Howell points out, to the fact that such nests would be hard to observe.

As mentioned above, nests of the tree mice were looked for in suitable places in Marin and Santa Cruz Counties but were not found. If *Phenacomys longicaudus* formerly had a wider distribution than now it would not be at all surprising to find them there. Unless they are found to occur there in the future, the vicinity of Occidental will remain their southernmost limit of occurrence; for the forest ends there and a considerable area of open country intervenes before it is again found in Marin County. Mendocino City, which is about seventy miles

north of Occidental, was formerly the southernmost station known for *Phenacomys longicaudus*.

The specimens spoken of above are preserved in the collections of the Museum of Vertebrate Zoology and of Ralph Ellis, Jr.

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HABITS OF A YOUNG FLYING SQUIRREL (GLAUCOMYS VOLANS)

BY ROBERT T. HATT

The development of behavior of various species of Sciuridæ has been recorded in a number of recent papers. Comparison of these cases reveals interesting differences and similarities between the species. At the present time, however, there are not enough individual histories recorded to permit of generalizations on the significance of these variations. To place one more history on record the following notes are published.

The individual to which these notes refer was born of parents which were from stock hybrid between *Glaucomys volans volans* and *G. v. querceti*. Both this young one and its parents were born on the Red Squirrel Farm at White Plains, New York, a privately owned squirrel colony which I have elsewhere described (1929, Natural History, vol. 29, pp. 319–326). It is a pleasure here to thank Doctor Lillian Delger Powers for the gift of the squirrel and the information which she was able to give me concerning its origin.

This squirrel, a male, was born on March 13, 14, or 15, 1929. For convenience in reference the middle date is assigned as its birth date, and the ages given herein all refer to March 14 as its actual day of delivery. The animal had no litter mates.

The squirrel came into my possession at the age of forty days. To that day it had probably never left its nest box, except when lifted out,

and had probably had no food other than its mother's milk, though there is the possibility that it had sampled food brought into the nest by its mother.

With change of ownership there was of necessity change in food and environment. This change may have tended to bring about the appearance of new habits at a slightly earlier date than life with its mother would have done. The sudden change in food probably accounts for the loss in weight of the individual between the fortieth and forty-seventh days.

Size.—The usual external measurements were taken on the fortieth day. These were: total length, 164 mm.; length of tail vertebræ, 75 mm.; length of hind foot with claws, 25 mm. Subsequent to this the increased vigor of the animal made accurate measurements impossible. The weight record, however, was kept until the 147th day, by which time the squirrel had apparently reached maturity.

Weight.—

	Grams
40 days	26.0
47 days	25.5
54 days	29.1
61 days	32.7
68 days	37.1
75 days	43.4
82 days	47.1
89 days	47.5
97 days	53.2
103 days	57.0
112 days	60.7
117 days	62.5
125 days	60.6
132 days	61.0
139 days	58.0
147 days	57.0

Pelage.—*40 days:* The squirrel at this age was fully furred and marked as an adult. The tail was as distichous as that of a mature squirrel. The full complement of vibrissæ was well developed.

112 days: Shedding, the onset of which was not noted, was at this time about half complete. The new coat covered the head and the back caudally to the level of the iliac crests. It was short and dense, which gave it a very luxurious smoothness in contrast to the uneven, juvenile appearance of the old coat. The line of demarcation between the two coats was abrupt.

125 days: The line of separation between new and old coats had at this time advanced very little since the 112th day, suggesting that replacement is very slow.

Adolescence.—The testes were noted to have moved into the scrotum by the 108th day. They were not in this position on the 101st day.

Voice.—*42 days:* The squirrel made squeaking, protesting notes on being removed from a sleeve.

52 days: For the first time this squirrel gave vent to the loud, whistled piping so often used by flying squirrels that are apparently angry or startled. On this occasion the notes seemed to have been provoked by my making some sudden noise after being quiet for a considerable time. For several minutes the squirrel had been on the point of making a leap to me, and was, it seemed, annoyed at having its calculating observations interrupted.

136 days: On being slightly injured the squirrel uttered a shrill cry. When I attempted to hold its injured hand that I might apply medication, it made a protesting churr similar to a note of the American red squirrel.

Locomotion.—*40 days:* The squirrel moved about freely on a horizontal surface. Climbing was well accomplished on a rough surface. The animal showed a marked tendency to climb wherever there was anything climbable.

Attempts to hop on the horizontal were not successful as the limbs were too weak. The animal did not leap, though several times it looked over the edge of its nest box or the edge of a table as though it were tempted to leap.

In moving head downward on a vertical surface, the squirrel attempted to hold on with the hind feet reversed in the manner of adult tree squirrels, but at this it was not eminently successful.

43 days: The squirrel twice jumped onto a smooth vertical surface as though to climb it but, of course, fell each time.

44 days: The animal at this age was almost ceaseless in its efforts to climb, run, jump and explore. It was able to climb the sides of its cage, which were merely vertical wire spokes about half an inch apart. Jumps along the horizontal were fairly well made and a leap with a vertical drop of six inches was accomplished.

In progress along a horizontal wooden bar one-half inch in diameter, the squirrel used its tail both accurately and forcefully to maintain balance.

50 days: The squirrel escaped from its cage during the night and got down from the top of a chest 68 inches high. Making its way to my bed

the animal woke me up. I returned it to the top of the chest and lighted the room. Soon the squirrel came to the edge of the chest, paused a moment and launched into the air. Though it had aimed at a chair only four feet away the mark was missed. Immediately the squirrel ran over to my bed and climbed up to me. Milk was offered to the infant which drank it ravenously and after this ate a pine nut.

57 days: The squirrel leaped against smooth tiled walls several times, failing in its attempt to catch hold. The nature of a surface seemed to mean little to the animal. It was unable to climb on the vertical surface of a broadcloth shirt, though this was frequently attempted.

65 days: The flying squirrel at this age was very active in leaping. The following measured jumps were taken:

Horizontal range, 55 inches.	Vertical drop, 28 inches
Horizontal range, 55 inches.	Vertical drop, 28 inches
Horizontal range, 79 inches.	Vertical drop, 68 inches

When the take-off was horizontal the squirrel's back was arched and the line of projection was as nearly horizontal as possible. In the air the arms and legs were fully extended and the tail quivered violently. The rear end of the squirrel fell more rapidly than the front end so that, alighting on a vertical object, the limbs were in a position more favorable for securing hold quickly, while alighting on a horizontal object the rear feet touched the ground first and absorbed much of the shock.

112 days: When for any reason the squirrel missed its mark, it landed well on its feet, even though the distance for adjustment was but a few inches.

Reaction to light.—*40 days:* The squirrel showed no aversion to strong light, either solar or electric, even though exposed to it for about a quarter of an hour.

100 days: At this age the animal showed marked avoidance of strong light, though it would keep out in a well lighted room and remain quite active there.

Defence.—*100 days:* A tendency to bite, objectively, though not maliciously, was evident at this age, though some provocation was always associated with such behavior.

Nest building.—*44 days:* Given a piece of cotton cloth, the squirrel labored long but ineffectively to fluff it up into a nest. This failing, an attempt was made to pull the mass over as a cover.

At a later date nest building was efficient but no observations on this were recorded.

Storing instinct.—*57 days:* There was no trace of storing tendencies. All food was sampled and left where found.

61 days: The animal carried a nut, which it did not immediately eat, into its nest box. This was the first observed sign of a storing instinct.

68 days: Storing behavior was well marked, and much uneaten food was being carried into the nest.

Toilet and medication.—*40 days:* The squirrel washed its face thoroughly and rapidly while sitting up. It also stretched and yawned.

41 days: The squirrel was seen to scratch itself with a hind foot.

54 days: The toilet was made rapidly and dextrously. The tail was cleaned and combed with the incisors and tongue while the tail tip was held by the paws. The abdomen was cleaned by licking and scratching. The face and the back of the head were dressed with the fore feet. The fore arms were washed with the mouth, one hand being used for holding the opposite arm during the process.

The fur of the chin, cheeks and sides was dressed by rubbing these surfaces against a rough board in the direction of hair growth.

136 days: The squirrel caught its right hand between a closing door and the door frame. This cut off the terminal phalanx of the fourth finger and injured the other fingers, particularly the fifth. The squirrel came down immediately to the person who had moved the door. The severed finger was bleeding freely. Without delay the animal sat up and holding the injured hand with the opposite member licked it. I tried to hold the squirrel in order to apply mercurochrome but objection was made to the method and remedy, the latter being soon licked off. Within a few minutes the squirrel ran about the room using the injured hand a little.

137 days: The right hand was swollen and the fingers adhered to each other. Despite this the animal ran about and jumped almost as freely as before the accident.

138 days: The injured hand was used a great deal in feeding and in locomotion. It was still licked from time to time.

Food, feeding and gnawing.—*40 days:* The squirrel was not supposed to have had solid food up to this age, though it may have received some from the mother. On this day the infant was taken from his mother and fed from a medicine dropper a small portion of a luke warm mixture of two teaspoons-full of condensed milk and a half teaspoon-full of Scott's Emulsion in a half cup of water. The young squirrel mouthed one's skin, the surface of a towel, and some other objects as though in search of a nipple. Some time was spent gnawing at the edge of the cardboard nest box.

offers food as well as cover from enemies. This is chiefly along the higher and drier ridges which line the bayou banks. They also occur to a less extent in the vast tidal marshes.

These rodents are not the only occupants of the ridges of the bayou banks, for a harvest mouse (*Reithrodontomys fulvescens aurantius*), a white-footed mouse (*Peromyscus gossypinus gossypinus*), and a cotton rat (*Sigmodon hispidus hispidus*), also share this area. On Avoca Island, which is an artificially drained area, these four rodents have been found to share the protection of a species of huge and very common thistle. Nests of shredded grasses were found under the large basal leaves of the thistle. They were also found built high in the tangled vegetation, usually above high water level. In dried situations, which were not normally reached by the tide, the nests were placed on the ground, usually in a slight depression. The nests were made of finely shredded dry grasses and sedges, which were loosely woven together. Only the leaves were used and these were most commonly from the following plants; *Panicum hemitomum*, *Spartina patens juncea*, and *Phragmites communis*. Along the bayou banks and other dry areas the runways formed a maze under the thick vegetation and were indistinguishable from those of the ubiquitous cotton rat.

When shaken or frightened from their nests, rice rats are surprisingly agile and dart with exceeding rapidity for cover. If pursued farther, they do not hesitate to dive into the water and swim rapidly and strongly underneath for some distance.

In captivity, they were very inquisitive and soon learned to run wheels placed in their cages and to drink from their water bottles. They were always ready to bite whenever handled, and they never became tame.

Under natural conditions, the *Oryzomys* feed chiefly upon the seeds and succulent parts of the various marsh grasses and sedges found in this region. In captivity, they thrived on green foods and grains. They relished occasionally small raw fish and bits of raw meat. I have never tried to capture them in traps baited with meat as I was always successful in using rolled oats. The following comprised the variety of foods eaten in captivity; rolled oats, wheat, corn, rice, oats, cornflakes, puffed wheat and rice, bread, oat seedlings, dog mash, apples, peaches, watermelon, muskmelon, sweet potatoes, fish, and raw meat.

The food of three rice rats, averaging 53.3 grams in weight and kept in one cage, was weighed over a period of nine days to ascertain the approximate amount consumed per day per rat. The following results were obtained: food consumed by 3 rats per day, 38.2 grams; food con-

sumed by 1 rat per day, 12.7 grams. Hence, each rice rat consumed 23.8 per cent of its live weight per day.

In captivity the rice rats were very cleanly. They spent a large portion of their time washing, cleaning and combing their hair, tail and paws, using their tongue, fingers and claws for these purposes. If kept in dry cages without dust their fur soon became matted but this was readily brought back to normal by placing a little dirt or sand in the cage. When the animals were first captured, open shallow pans were used for water but it soon became apparent that these pans were used as defecating and urinating posts. When inverted bottles were used for water the rice rats soon learned to deposit their feces in one corner of the cage.

In regard to the breeding habits my observations show that the breeding season extended, in captivity, from February to October inclusive. Two female rice rats, although kept with males, did not breed during the months of November, December and January.

In breeding these animals, the male was placed in the same cage with the female. As successful mating depends entirely upon the desire of the female it was easily seen by her actions whether she would allow the male to mate. If she was in oestrous or heat she would go through a characteristic mating action. If not in oestrous she would have nothing to do with the male and would fight him if he was too insistent. In one instance an adult female killed a half grown male that was courting her. The females were usually in oestrous immediately after the birth of a litter of young. Mating was observed on several occasions. The female followed the male about the cage smelling his genitalia until he turned and followed her. The female would then attempt to run away from the male but soon stopped after taking a few steps, when copulation would take place. After copulation both animals would lick themselves thoroughly. Several copulations took place within a very short time. One female, separated after one copulation, failed to become pregnant. Later, however, when mated again with the same male she became impregnated. After several copulations the female would refuse the further attentions of the male, and if she had a litter of young she went to her nest and nursed them, fighting the male if he came too close. Thus, on one occasion, although several copulations were observed at about 8 P.M., no further copulations took place after this time, although the male was not separated until the next morning. The gestation period was found to be twenty-five days. This information is based upon five checked matings, in three of which copulation was seen to take place

and the young to be born. In three cases the period of gestation was twenty-five days. In other instances the male was removed from the female after 24 hours.

As the females mate within 10 hours after the birth of the young and the gestation period is 25 days, nine litters a year would be the maximum number one female could bear in this time. One female under observation produced six litters, totalling 20 young, during such a period. The dates are as follows; May 1, 1926, July 23, August 18, October 6, March 20, 1927, and April 13. Another litter was born on June 20. A daughter of this female born on May 1, 1926, produced young when but 75 days old, showing that the females may be sexually mature when only 50 days of age. This first litter was followed by another of three on August 5. During 1927 this female had two litters, one on March 28 of three, and another on April 22 of two. She had produced four litters of young, totalling nine, before she was a year old. The number of young in a litter varied from one to five, with an average of three. The young female produced smaller litters than did her mother. This is shown by comparing the average of 23 young borne in seven litters by the old female to the nine young borne in four litters by her daughter. The mother averaged 1 young more per litter than did the daughter.

At birth the young are blind, wrinkled, and covered with a sparse coating of fine, short hair on the legs and dorsal part of the body. The vibrissae are well formed at birth; perhaps this assists the young to find the nipple. When newly born, the young varied in weight from 2.35 grams to 4.0 grams. The average of thirteen young was 3.14 grams. When two days old, the young are dark gray above and whitish below. At six days of age, when the eyes open, the young are covered with a coat of fine hair of a russet brown color on the upper surface of the body and white below. The mammae, in this race eight in number, are 4 in the pectoral region and 4 in the inguinal. Before the hair is very long on the lower part of the body, the sexes can be easily differentiated by the prominence of the mammae in the infant females. The young are able to run about actively when their eyes open and in eleven days they are weaned.

An attempt was made to study the migration or roaming ability of these small rodents. On December 31, 1926, two males were marked and liberated at the place of capture. The next day male No. 2 was recaptured fifty feet away from the place of liberation. Further studies were curtailed because of a marsh fire that burned all the vegetation of this area.

Rice rats are by no means voiceless, as they have a number of squeaks that vary with their actions. When a stranger is placed in a cage with other rice rats there is very likely to be a fight and the squeaks of angry and troubled animals are very different from those of contented ones. The young when merely disturbed have a lower voice than that of the adults, but when left for some time, and hungry and cold, their presence is very readily noticed by the loud and long cries.

I have found that the water moccasin (*Agkistrodon piscivorus*) and the barn owl (*Tyto alba pratincola*) feed upon these rice rats. Undoubtedly other owls, and hawks as well as carnivorous mammals also feed upon them.

BEAVERS AT WORK ON THEIR HOUSE

By Tappan Gregory

[*Plate* 10]

When we came to the Salmon Trout River in Marquette County, Michigan, on the 14th of October, 1928, it was with the idea of setting a camera at the end of a large log which lay across the river at a point where Sullivan Creek was dammed by the beaver. We knew that wildcats had been trapped here and that since the last had been taken, tracks had been seen, indicating that this crossing was still in use by the cats, or at least by one of them. But the problem, which seemed so simple at the outset, developed unforseen difficulties in the high water, resulting from steady recent rains. Obviously, it was out of the question to set for cats at a log covered by two feet of roaring torrent. Casting about for some alternative, we were favorably impressed with the appearance of a beaver slide coming into the river on the opposite bank. The crossing of the stream was an obstacle which gave us pause until at length we were able to cross on a tree farther up-stream that hung clear of the water, except at the near end, which for a few feet was perhaps six inches below the surface. Rain commenced gently while we were still at work and continued for about an hour and a half, but not sufficient fell to swell the river enough to interfere with access to the camera the next morning. We found the flash discharged, the trip wire broken and what looked like beaver tracks on the slide. In half an hour, everything was in order again,—the camera reset and a new wire in place. The picture taken the night before was of a beaver,—not entirely satis-

BEAVERS AT WORK ON THEIR HOUSE

Upper: Another load of mud is deposited. Lower: This one either brought mud up the other side of the house or is shirking.

factory, as the subject, apparently, had started a leap preparatory to a slide into the river. I am inclined to this explanation of the blurring of the animal's forequarters because it has seldom happened in pictures which we have obtained of beavers traveling along, that the speed of their motion was sufficient to blur any part of the image.

Several days later after continued rains that made it impossible to take satisfactory pictures we picked up everything preparatory to resetting upon a nearby beaver house, where we had seen two beavers swimming around and diving. A camera had already been there for six nights, bringing in three beaver pictures, another shot that was too foggy to tell us anything, and two of birds flying through the trip wire. Something was wrong with this apparatus, however, and none of these shots was successful. The fact that beavers kept coming to this set night after night, and the tangible evidences of daily plastering going on at the house, led us to believe that these intrepid and diligent workers might continue their nightly operations and so make it worth while to substitute the trap which we had just brought in in good working order. For the next two nights, October 19 and 20, we left the new set in the same position as the old, trained on the side of the beaver house, with a trip wire extending across the pathway by which the beavers ascended from the water. Low temperatures, almost daily rain, with ensuing fog and mist at the water's edge after sundown did not simplify operations. I found the flash set off and the trip wire sagged on the morning of the 20th, and the fact that the negative of a beaver coming down the house was clear and sharp, without any suggestion of mist, makes me think that this beaver was responsible for the flash heard at six o'clock the preceding evening. That night we were again accommodated by a beaver, this time going up the house, apparently with mud for plastering. It broke the wire in the course of its journey and we thought that we could identify fresh mud at a point on the house where it would likely have been dropped had it been carried by the animal shown in the picture. Of course, it was disappointing not to have a pose which would show plainly this interesting mud-carrying practice. It seemed that the chance of this sort of view might be better on the other side of the house, where also, as far as we could tell, there was more activity. Again we were disappointed in the result, as the beaver's tail in the next picture, taken on October 21st, was only partly out of the water and the beaver itself was not walking exclusively on its hind legs, as we hoped to catch it. We moved the trip wire up the house a short distance and kept hoping that the beaver might follow an indicated

runway which led diagonally toward the camera, but, although other pictures were taken, and although each time the signs pointed to the fact that mud was being carried, neither shot gave us the view for which we had hoped, and we were then compelled to abandon further effort and once more desert the woods.

Chicago, Illinois.

A COLONY OF PACIFIC PALLID BATS

By Tracy I. Storer

A colony of Pacific Pallid Bats (*Antrozous pacificus* Merriam) was removed from the walls of a residence in Berkeley, north of the University of California campus, on June 24, 1919. There was a total of 38 individuals obtained (not all of the colony, however) and these included males, females and young. The adults had entered through louvres in the attic and had concentrated in the west wall of the second story adjacent to a fireplace. The members of the colony which were removed comprised the following: 8 adult or nearly adult males; 2 females with 2 young; 3 females with 2 embryos; 4 females with 1 young; 1 female with 1 embryo; 3 females, without young on teats or *in utero;* and 9 young not attached to any female, a total of 38.

When the bats were first seen by the writer, just after having been removed from the wall, some of the larger young bats were already crawling about by themselves and may have been partially or entirely weaned. But even the largest of them, when freed at a height of several feet above the floor of a room, was unable to fly. All so tested quickly sank to the floor; their wing beats served only to ease the force of their descent. So it seems unlikely that a young bat of this species would forage alone until nearly or quite full grown.

The young bats while still with their mothers usually clung to the teats; less often they gained hold on the back of the female. In either situation this hold by the teeth was so secure that they could hang suspended from the body of the female when she was climbing or even when she was flying. A female released in a closed room flew 20 feet or more with her two half-grown young holding only by the teats. The nearly full-grown young do not seem to be carried in this manner. Females with young two-thirds grown would often drag the latter in a very hit-or-miss manner, when climbing about in a wire cage. The

young seemed not to mind, being evidently content so long as they could hold fast to the parent. The smaller-sized young were more adept at holding to their parents. They clung very closely and sometimes gained additional holds with their hind claws on the side of the body or on a wing of the female. When a young bat became loosened from the nipple of the female the teat retained for some time the imprint of the youngster's teeth.

When a young bat was set free on the floor in a room with numerous windows on the west and north, no matter in what direction the bat was faced it at once turned away from the light and in several trials always went directly toward a row of black pamphlet cases, the darkest objects in the room and away from the light. Arriving at these it would endeavor to climb over and back of them, thus displaying a strong negative phototropism. Its progress on the smooth shellaced linoleum on the floor involved the use of both fore and hind limbs, these being sometimes moved alternately, again the bat used a sort of "breast stroke" and flopped along, moving the wings somewhat as an adult would in flight.

The rate of respiration in these bats was very rapid. One quiet individual breathed, as shown by abdominal pulsations, at the rate of 120 inspirations per minute. When the animals were moving about or when they were squeaking the breathing was much more rapid. The breathing was sometimes irregular, two or three breaths being taken in rapid succession, then a quiet interval of appreciable duration intervened before the movement began again.

During the first twenty-four hours in which the bats were in captivity much excrement was voided, but after that time there was very little, probably because the animals had had no opportunity to feed. This would suggest that most of the food material passes through the digestive tract within 24 hours.

After having been in captivity for three days the bats were chloroformed and 21 of them immediately weighed and measured. Some change in weight undoubtedly resulted from their having been kept without food for more than twenty-four hours, but the changes for the various members of the group were probably more or less of the same order for those of adult or nearly adult size. Starvation of mammals while suckling young usually results in a rapid decrease in the amount of milk formed in the mammary glands so it is not likely that the young profited to any great extent at the expense of their mothers during this three-day fast. Furthermore, some bats are believed not to forage abroad every evening (as when kept in by inclement weather) and if this

is true, intervals of forty-eight hours and possibly even longer may intervene between successive feedings by adult females in the wild. The weights here given may, therefore, not be much if any different from the

TABLE I

Weights and measurements of members of colony of Antrozous pacificus

MUS. VERT. ZOOL. NO.	SEX		WEIGHT	TOTAL LENGTH	TAIL (EXTERNALLY)	HEAD AND BODY LENGTH	HIND FOOT	EAR FROM CROWN
			grams					
29994	♂		21.7	123	45	78	15	28
30004	♂		21.3	129	46	83	15	26
30007	♂		20.3	124	44	80	14	26
30008	♂		19.7	123	45	78	14	25
30010	♂		20.4	127	46	81	15	27
Averages			20.7	125.2	45.1	80	14.6	26.4
29996	♀		24.8	125	45	80	15	27
29998[a]	♀		24.8	123	45	78	15	27
30000[b]	♀		21.3	125	46	79	14	27
30002[c]	♀		22.8	129	46	83	14	28
30005	♀		22.7	123	44	79	14	27
Averages			23.2	125	45.2	79.8	14.4	27.2
30009[d]	♀		29.0	122	43	79	15	25
30011[d]	♀		28.3	128	44	84	15	29
30012[e]	♀		24.8	122	41	81	15	29
29995	♂	jv.	3.5	58	17	41	11	9
30016	♂	jv.	8.4	77	24	53	14	16
30003	♀?	jv.	8.7	81	23	58	14	17
30015	♀	jv.	9.6	84	27	57	15	19
30001	♂	jv.	10.2	90	26	64	14	19
30014	♂	jv.	10.4	93	30	63	15	20
29997	—	jv.	13.6	99	31	66	15	21
29999	—	jv.	15.7	82	24	58	14	16

[a] Mother of 29999.
[b] Mother of 30001.
[c] Mother of 30003.
[d] With two embryos.
[e] With one embryo.

weights of animals taken in the field. In any event the measurements are not invalidated by this confinement, and having been made under similar circumstances by the same person are strictly comparable. The

measurements (in millimeters) and weights (in grams) are given in Table I.

Several conclusions may be drawn from the data pertaining to this colony of *Antrozous pacificus*. Males and females commingle during the season when the young are being born and reared. The single male dissected showed testes somewhat enlarged. Females bear either one or two young. Young are born over a considerable period of time, since there were some still *in utero* while others were half to two-thirds the weight of adults and other young were intermediate in size. Young probably need to attain nearly the size of adults before venturing forth to forage. The feet of the young (of importance even in climbing about in the colony) are disproportionately large at birth and rapidly attain adult size, whereas the tail is slower in attaining its full length.

The smallest bat in this group weighed 3.6 grams. Pregnant females were 2.1 to 3.5 grams per embryo heavier than non-pregnant or suckling females. The birth weight must therefore be about one-tenth that of adults. In one instance the two young attached to a female were respectively male and female. Adult females at this season weigh more than adult males, although their bodily dimensions are practically the same. The sex ratio of the adults here obtained is not dependable as indicating the composition of a "colony" since all the individuals were not captured.

The data from this colony agree in general with those for the species obtained elsewhere in California. Specimens from a colony at Snelling, Merced County,[1] collected on May 27, 1915, comprised one non-breeding male and 19 females, of which 15 contained 2 embryos each, 3 had a single embryo each, and one had no embryo. A female taken at Dale's, Tehama County, June 2, 1924, gave birth to two young the following day and she weighed 19 grams *post partum*.[2] Other females taken May 27 and June 28 in south central California contained two embryos each.[3]

The material regarding the Berkeley colony was gathered while the writer was a member of the staff of the Museum of Vertebrate Zoology. The Director, Dr. Joseph Grinnell, has kindly consented to its publication at this time.—*University of California, College of Agriculture, Division of Zoology, Davis, California.*

[1] Grinnell, J., and T. I. Storer. 1924. Animal life in the Yosemite (Berkeley, Univ. Press), pp. 60–61.

[2] Grinnell, J., J. Dixon, and J. M. Linsdale, Univ. Calif. Publ. Zool., vol. 35, 1930, p. 457.

[3] Grinnell, H. W., Univ. Calif. Publ. Zool., vol. 17, 1918, p. 356.

RANDOM OBSERVATIONS ON HABITS OF SOUTH AMERICAN MAMMALS

By G. H. H. Tate

The relative lack of published information concerning the habits and behavior of South American mammals, contrasted with the wealth of systematic and taxonomic literature, has prompted me to gather from my journal any accounts, no matter how brief, that bear upon the activities of Neotropical mammals. The information is drawn either from my own experiences in Ecuador, Bolivia, Venezuela and Brazil, or at first hand from natives who have worked and hunted for me and particularly from A. M. Olalla, a citizen of Ecuador who has collected for many years. The species and genera are dealt with more or less in systematic order.

Monodelphis.—These short-tailed opossums are mainly terrestrial and nocturnal. They are occasionally trapped on fallen logs, especially if these bridge streams. At Anandabaru in British Guiana one of them was seen running between the double cane walls of a hut, dragging with its tail a piece of newspaper. The paper was grasped apparently by curving the entire tail downward over it and was probably being taken to the animal's nest.

Caenolestes. These marsupials, which have been styled "living fossils," have been carefully worked out from an anatomical viewpoint by Dr. Osgood and others. It was believed until a few years ago that *Caenolestes* was an exceedingly rare animal. The fact is that in Ecuador, as soon as one becomes acquainted with its habits, it can be caught as readily as any other fairly abundant animal. The small-sized *fuliginosus* and larger *caniventer* groups have rather markedly distinct habitats. The former occurs in Sub-paramo zone at the upper border of the tree line; the latter in subtropical forest. *Caenolestes fuliginosus* is abundant in small brushy ravines near water. Frequently the runways, which are used in common with mice, are found to pass up and down the steepest parts of gullies, so that traps set there when sprung fall to the length of their tie-strings. The fact that one *Caenolestes* has been caught the evening before will not deter a second specimen from entering the trap, and at Mt. Pichincha I have caught specimens with the same trap on four successive nights. The animals are probably entirely insectivorous. A specimen taken alive on Mt. Pichincha did not use its tail in any way as a prehensile organ and in spite of what Lönnberg says in this respect, I have found no tactile adaptations in the tail.

Armadillos.—In Eastern Ecuador it is not uncommon to come across a large hole which your Indians will tell you was made by an armadillo. However, I have found it as a rule very difficult to find these animals. In western Ecuador the nine-banded form is apparently fairly common since old carapaces are sometimes found on the mountain sides.

Near Mt. Duida the natives state that they have two methods of catching armadillos. One consists of making a sort of trap which fits over the mouth of

the hole through which the animal tries to force its way as it comes out. The more it pushes forward, the tighter the trap fits over it. The men induce it to leave its hole by pouring in a quantity of water. The other method is as follows: The armadillo is run into its hole by the Indian's dog. The man cuts a long forest vine and inserts it into the hole as far as it will go. He then twirls the end between his palms, the revolving vine brushing about inside and gradually advancing along the curves of the burrow. Meanwhile a companion, by listening intently with his ear to the ground, is able to judge the direction taken by the armadillo by the brushing of the vine under ground. When the armadillo is apparently at the end of its hole, he quickly drives three or four stakes across the spot where he thinks the burrow is, cutting off the animal's retreat and as fast as possible the men dig down and unearth it.

Choloepus.—The chief point of interest which I have remarked with regard to these sloths refers to a specimen shot in a rain forest in western Ecuador, which had the fur literally alive with a small species of moth whose larvae possibly fed on the greenish alga which grew in the hair. The moths, probably *Pyralidae*, flew readily, but returned quickly to the fur, I believe this condition has been remarked before, but this is the first time I have come in contact with it.

Myrmecophaga.—On the upper Rio Branco savannas in Brazil we saw a pair of giant anteaters with one young one. They were wandering about in the grass near some termite hills and paid no attention to the approach of the horses until we got within a hundred yards. Then the male made off at a sort of lumbering gallop, much more rapid than I would have thought possible. The female, which stayed with the young one, turned her head slowly from side to side with her long snout pointed at us as though she were testing the wind which blew from us to her. Somehow she made me think of pictures I have seen of elephants with their trunks extended to sample the air.

A day or so later we had hunted for only about fifteen minutes when Domingos put up a fine large anteater which had already seen him and was running away when he got off his first shot. The speed of the anteater was about equal to the maximum we ourselves could achieve by running, gun in hand, through long grass.

In eastern Ecuador the flesh of the giant anteater is commonly eaten. A story with regard to these animals told by Olalla is as follows: An Indian with his son and a dog were hunting. They came upon a pair of giant anteaters and shot the male, which was in front. As is customary with these Indians, the man reloaded with the minimum amount of ammunition, shot being a very scarce commodity. He fired again, but only wounded the second animal. The little boy valiantly tried to strike it with a small machete and the animal, feeling the slight blow, drew the child into her embrace and with her tremendous claws killed him. Olalla went into considerable details about the boy's death, which need not be repeated. He stated that he himself was present and at first was unable to shoot because the boy was between him and the animal, but when the child had been killed, he "shot through the two of them."

It is generally thought that the giant anteater will not climb. G. K. Cherrie has a photograph of one half way up the trunk of a palm tree, whither it had been driven by dogs.

Tamandua.—My most intimate contact with this animal occurred on the Island of Puna in Ecuador. While I was hunting with a light at night in fairly dense dry

scrub, a considerable noise a little way from the trail attracted my notice. I crept through the brush, keeping the light playing ahead of me, but could make out nothing. Eventually the forms of two of these anteaters became visible. They paid no attention whatever to the light but continued tearing open an old tree stump upon which they had been working. In an effort to see whether their eyes would shine, I retreated and advanced several times and am convinced that in these animals no such phenomenon occurs.

Tadarida brasiliensis.—These Molossine bats are very common along large rivers of the Amazon drainage. This is the bat which may be seen at dusk skimming some six inches above the surface of the water, when on account of light conditions it is very difficult to shoot. Apparently invariably its hiding place during the day is in split granite boulders at the water's edge. As a rule the cleft chosen is partly submerged and partly exposed, and the bats herd together in the crevice within a foot or so of the water.

Desmodus rufus. Vampire bats are widely spread in tropical and subtropical South America. They may be found in caverns, mine shafts and less frequently in holes in trees. So far as I am aware they constantly use all four limbs when crawling from place to place in their dens, instead of hanging up by the hind legs as *Myotis* and other bats do. The animals, which are very tenacious of life, creep rapidly about the walls and ledges in caverns or may be seen sitting in holes in the walls with just their heads showing. Probably this behavior is related to the extreme development of the thumb.

Anthorhina. These large-eared bats were met by me on one occasion only. In a forest in western Ecuador I was hunting by jacklight quite late at night. As I passed a rotten tree trunk, only some eight feet of which remained erect, I saw by faint moonlight several bats fly out and disappear. When repassing the tree an hour later the bats which had returned to the tree flew out again. I returned the next morning with a mosquito net and after wrapping the net around the entire tree, managed to push the tree over and break it open. In this way seven specimens of *Anthorhina* were taken. Apparently the bats fly in and out of their roosts at all hours of the night.

Dactylomys.—Olalla says that he used to take these large syndactylous rats in the afternoons in canebrakes on the islands of the various rivers visited by him in eastern Peru. He could recognize them by the peculiar call which the animals uttered, something like "Kuk-kuk kuk-kuk." Their local name is *conocono*.

Isothrix.—Olalla says that this hairy-tailed Octodont lives in holes in large trees along the borders of rivers. It sits in the entrance of the hole during the afternoon with just the head showing. The method of catching the animal is to paddle quietly along the banks of the streams at dusk and shoot it as it sits at the mouth of the hole. Its local name is *conocono pequeño*.

Echimys.—These stiff-spined Octodont rats, which are trapped rather rarely in the Amazonian region, came to my notice only once as living animals. This was at Cuchivano in northern Venezuela, in a region where the forest is dry and dwarfed. They ran actively along the limbs and through the branches of trees in a rather squirrel-like manner and in all probability it will be found that they live in holes high above the ground, much as *Isothrix* does.

Heteromys.—The form of pouched rat found in western Ecuador lives in humid forested regions in the Province of Manavi and northward. It is locally very

abundant and to be found as a rule on slopes fairly near water courses. In eastern Venezuela, where I came across another form, the animal is exceedingly plentiful in the humid forests and coffee plantations about the slopes of Mt. Turumiquire. In the cheek pouches it was usual to find seeds and coffee beans. In one specimen taken, one pouch contained a coffee bean and a large unknown seed and the other pouch a large cock-roach.

Ichthyomys.—These rats, commonly known as fish-eating rats, were first made known by Söderström, the former Swedish consul at Quito, Ecuador. He used to tell a humorous story of how he went down to Guapulo and persuaded the Indian population as they came out of church on Sunday morning, to spread out over the swampy fields and turn over stones in search of these animals. I went down myself to Guapulo and found that the place, which is now mainly under cultivation, offered little hope that the fish-eating rat was still resident. However, I set a series of traps there and managed to take one specimen. An allied genus, *Neusticomys*, described a few years ago by H. E. Anthony, is much more plentiful. It can be taken along small "azequias" or irrigation brooks, which are used by the Indians to water their fields. To trap it there, the trap should be placed in a part where the current is very rapid and where the banks encroach, so that the animal when it emerges from the water to avoid the strong current is almost forced to cross the treadle of the trap. It is frequently taken also close to small waterfalls and in places exposed to spray from the water. Recently, in Venezuela, some fifteen hundred miles to the east of the Andes, a third genus *Daptomys* has come to light, which, instead of living in cold waters, is found along the rivers in tropical forests in company with *Nectomys* and *Proechimys*.

Lagidium.—Mountain viscachas, which are at home among the rocky slopes and talus slopes in Bolivia and nearby countries between the snow line and the timber line, were seen by me only once. On this occasion, after weeks of almost constant rain, the day dawned clear and at sunrise several of these grotesque little animals, with their rabbit-like ears and squirrel-like tails, were seen alternately leaping from rock to rock or sitting bolt upright to look about them. The mist and clouds soon closed in and I saw no more of them.

Hydrochoerus.—Near Frechal, Upper Rio Branco, Brazil, are some ponds formed by the overflow of the River Surumu during the rainy season, in which quantities of water hyacinths grow. Capybaras were abundant here. The first we saw was walking on a yellow sand spit. Sighting us, he paused, then stepped slowly into the water, gradually walking deeper and deeper until he became wholly submerged and lost to view. Shortly afterwards we came upon several small droves of the animals that ran along the borders of the ponds, herded together like so many pigs, and when pressed swam across to the other side. They were evidently reluctant to leave the vicinity of the water since no one of them attempted to break away over the savannas. They appear to be both diurnal and nocturnal, for I have had their eyes shine under the jacklight, and through the day they are often seen swimming across rivers.

Dinomys.—The ex-Swedish consul at Quito, Ecuador, had one of these animals for a long time under domestication. For some reason the animal had lost all the hair from its tail. It was perfectly friendly and very fat. A few years ago a fine specimen was in the "zoo" at Lima, Peru.

Olalla says that *Dinomys* lives in burrows which are usually placed under rocks.

This specimen, which was still very wild and restless, had been taken only a few days before, swimming in the salt water of the estuary about half a mile away from the shore. Unfortunately, probably because of neglect, it died some three days after I saw it, but the skin and the skull have been preserved and are in the Museum.

Felis.—The cats, on account of the difficulty of capturing or even of seeing them, may be mentioned together. The South American puma is by no means restricted to the mountains, but is captured from time to time in tropical forest, hundreds of miles from the highlands. A fine specimen which I am convinced made its home not in the highlands but in forests only a few hundred feet above sea level was taken during my last trip to Mt. Duida.

Jaguars are generally lowland animals and probably rarely reach an altitude above eight thousand feet. Jaguar tracks are very common throughout Amazonia and even in western Ecuador. Although the animal is not really rare, it is so shy and difficult to find that it must as a rule be hunted with dogs. The top of Mt. Duida was reached by a trail made up of a series of ladders leading from one ledge to the next up through the forested slope. One night a jaguar made the ascent of a little over a vertical mile up this ladder trail and after roaming over nearly five miles of the cut trail of the summit went down again before sunrise. Several of the Indians who worked for me went to the trouble of tracing out his tracks and found that the animal had at no time left the trail prepared by our party.

In the Upper Rio Branco a jaguar was taken by T. D. Carter while he was hunting birds. When he sighted it the animal had just killed a colt and was making a meal of it. Carter changed his load to buck-shot and keeping the trunks of the scattered trees between him and the animal managed to approach unseen to within shotgun range and kill it.

The other cats, while they are brought in occasionally, have rarely come to my notice in the wild state alive. An ocelot, which had been killed by an Indian's poisoned dart, was found on skinning to have the toe pads quite filled with long spines of the chonta palm. The tissues showed no trace of infection. I have shot *Felis yagouaroundi*, the red phase of which is common in the dry parts of the brush country near Mt. Turumiquire, Venezuela. Like other cats, it wanders hap-hazard both by day and by night in search of food.

Pseudalopex.—These wolf-foxes or fox-wolves of the high Andes have frequently been taken by me during my trips to the mountains. They generally lie up by day and range widely through the treeless paramos at night. Occasionally one may be started in the day time and shot with a rifle. They feed principally on rabbits, but one animal I recall had apparently made his latest meal of a skunk. The best way to secure them is by trapping. Three or four rabbit bodies, after the skins have been saved for the collection, may be tied together and dragged at the end of a rope around a circle of several miles, traps being set at intervals at suitable places baited with small fragments of rabbit meat. The keenness of these animals' olfactory sense is suggested by one being trapped when the rabbit body trail had been "cold" for three days with heavy rain.

Urocyon.—The gray foxes of South America have a very broken distribution, and so far as my observations go, are confined to the drier, more open country. H. E. Anthony took them in southern Ecuador with the aid of a jacklight. In eastern Venezuela I trapped for the animal with dried fish and one evening while

in camp I heard a sound at a nearby trap like a cat mewing. This proved to be a gray fox that was trying desperately to get away.

Icticyon.—These are the hunting dogs of South America. I have never come across them myself, but T. D. Carter met with one in British Guiana. In western Ecuador I was told that they hunt in packs of half a dozen. Their principal prey is the paca, which they run down relentlessly. According to the story which was told to me, the pacas make for water and, hoping to escape, plunge into it, but the hunting dogs follow and kill them there.

Nasua.—Coati are generally widely distributed and common in tropical South America. There are a number of forms, some of which in western Ecuador occur as high as 8000 feet. The males are almost twice as large as the females and are usually found by themselves, whereas the females generally run in groups of from four to eight. So different in appearance are males and females that in Ecuador they have been given distinct names: the males "anda solo," meaning "walk alone," and the females, "cuchuchu." In another part of the same country I saw a company of these animals made up of two females and eight or nine young, working through the woods along the border of a river, in late afternoon. They were noisy and apparently more or less fearless of attack by other animals. Upon sighting me they went up into the trees and scattered through the branches in all directions.

At Mt. Roraima we were interested to find droppings of some partly insectivorous carnivora under the ledges and sheltered places of the rocky summit. An Indian reported seeing a coati up there, but that it disappeared among the rocks and he did not capture it. The conditions on the Roraima plateau scarcely furnish a habitat suitable for coatis and it is my belief that at the time of the burning of the great forest on the approach slopes, these coatis may have been trapped by the fire and forced up the ledge which affords the only method of reaching the summit of the mountain. They may have lived up there for weeks until conditions were suitable below for them to descend again.

Potos.—Kinkajous, so far as I am aware, are strictly nocturnal and frugivorous. They utter a peculiar chirping sound as they go through the branches and when angry a series of shrill screams. They are, however, rather easy to capture, since one has but to locate the few trees in fruit in the neighborhood and wait patiently there after dark until the kinkajous come from the surrounding woods to feed. If there is a moon, the animals are observed running along the branches and across the vines that lead into the fruit tree. Moreover, since their eyes reflect light brilliantly they are readily shot. I have, however, on one occasion trapped a kinkajou on the ground. This happened in a growth of ivory nut palms in Ecuador, the trap being baited with banana. During the day, kinkajous live in holes in hollow trees. Occasionally young ones are secured by natives who are making clearings. So far as I am aware only one or two are produced at a birth.

Tremarctos ornatus.—In the rain forest of southwestern Ecuador, on a large plateau on the Andean slope at about four thousand feet, I came across traces of a pair of adult spectacled bears. I had a native hunter with me when we found the first signs, which the man said were five days old. Their footprints, which were longer and much broader than a man's hand, were indistinct, giving the impression that the feet were bandaged, since no claw marks were visible on the soil. As we followed the animals' trails up the "loma" the signs became fresher and

fresher until the native said that they were only one day old. We passed about six places where they had bedded down. The bears, evidently powerful animals, had broken down many trees two inches in diameter, and were feeding on the seeds of a palm called "pambili" trees from 80 to 100 feet high. They evidently climbed the trees and brought down the whole fruit-stalk, which looks somewhat like that of the royal palm. Numbers of the trees had been climbed, some of them several times, since they had both old and fresh claw marks. Other food was secured by breaking down young palms, tearing open the green stalk and eating the unopened leaves in the interior.

According to Olalla, in the region about Quijos in eastern Ecuador bears appear at a certain season of the year on the mountain sides to feed upon the ripe fruit of a certain tree. They construct large nests in the tree tops, whence they sally forth daily to feed, and to which they return to sleep. These shelters are made in a leisurely manner, only a few sticks per day, so that when you find just a few boughs thrown together in a tree you know that the bear is in the neighborhood and that he will be there for at least some weeks. When you return about a week later you may find the nest finished. Olalla spoke of the bears as "running through the tree tops like squirrels," something that is hard to picture.

American Museum of Natural History, New York.

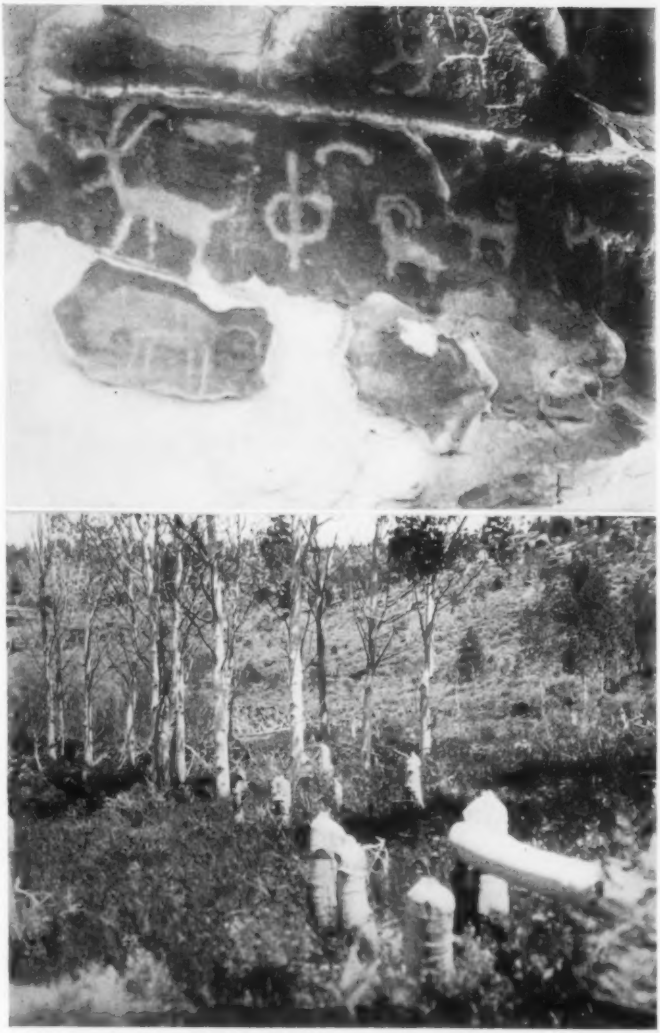
MAMMALS OF THE UINTA MOUNTAIN REGION

By Ruth Dowell Svihla

[*Plate 11*]

The Uinta Mountains lie in the northeastern part of Utah and extend in an east-west direction, forming a strategic area between the Great Basin region of southwestern Wyoming and the arid desert region of southeastern Utah. These mountains are separated on the west from the Wasatch range, which extends at right angles to them, only by the shallow valleys of the Provo and Weber Rivers. To the east the deep canyon of Green River affords a more effective barrier to mammal distribution.

Two summers (1928 and 1929) were spent in the field studying mammal distribution in the Uinta Mountain region. Collecting stations (see Fig. 1) were maintained from Green River City, Wyoming, south across the sagebrush plains to the foothills around Linwood and Manila, Utah, and thence up the northern slope of the Uinta Mountains to the top of the peak known locally as the Nipple. Most of the collecting was done on the northern slope of the mountains. This region represents approximately 6,000 feet in range of altitude from the sagebrush



UPPER: PETROGLYPHS OF MOUNTAIN SHEEP, ELK AND BISON ON ROCK CLIFFS ONE MILE NORTH OF LINWOOD, UTAH, SUPPOSED TO HAVE BEEN MADE BY UTE INDIANS

LOWER: GROVE OF ASPENS SHOWING BEAVER CUTTINGS. IN THE PINE BELT NEAR THE MANILA-VERNAL ROAD. BEAVER DAM JUST BEHIND THE GROVE

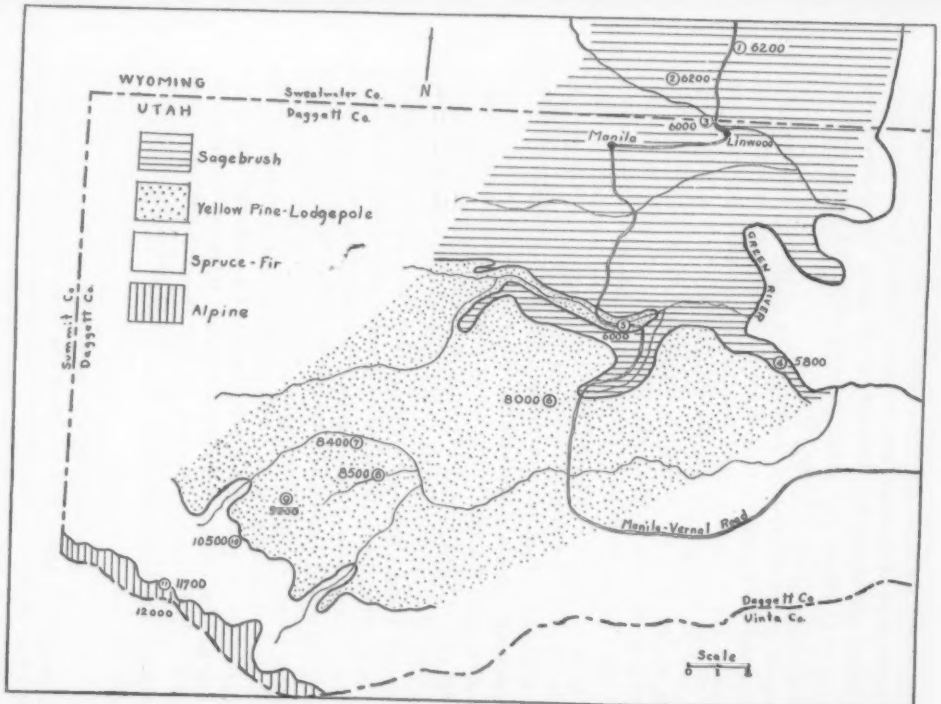


FIG. 1. Map of the north slope of the Uinta Mountain region showing the four vegetation belts (sagebrush, yellow pine-lodgepole, spruce-fir and alpine) and collecting stations as follows:

1, Sagebrush plains, 2 miles north of Linwood; *2*, Rock cliffs, 1 mile north of Linwood; *3*, Henry's Fork; *4*, Hide Out; *5*, Sheep Creek; *6*, Summit Springs (Elk Park is just south of this); *7*, Beaver Creek; *8*, Carter Creek; *9*, Granite Park; *10*, Beaver Dams; *11*, Timber line on the Nipple.

plains at about 6,000 feet elevation to the top of the Nipple at 12,000 feet.

Our collections numbered 609 specimens, the majority of which are now in the Museum of Zoology, University of Michigan. These represent 35 species and subspecies, in addition to which the presence and distribution of 11 others were determined by means of tracks, pellets, authentic records or personal observation.

The ecological distribution of the mammals of this region has been worked out and the results are now in press. Briefly, it was found that the ranges of the mammals could best be defined according to three schemes, namely, topographic zones, vegetation belts and habitat-types. An index of restriction that compares the forms which are restricted in habitat to those that are wide-ranging was applied to these three schemes with the result that the habitat-type showed the greatest relative degree of restriction. Hence, it was concluded that the mammals of this region are distributed primarily according to habitat-type, which here plays a more important part in determining their distribution than either topographic zones or vegetation belts.

The mammals of this general region are interesting not only in themselves but also in their faunal relationships. Checking the mammals found in the Unita Mountain region with those recorded by Cary (1917) for Wyoming, I find a close agreement. Compared with the Colorado fauna (Cary, 1911), ten forms (*Citellus armatus*, *Dipodomys ordii luteolus?*, *Eutamias umbrinus*, *Glaucomys sabrinus bangsi*, *Lepus townsendii townsendii*, *Marmota flaviventris nosophora*, *Ochotona princeps uinta*, *Perognathus parvus clarus*, *Thomomys pygmaeus* and *Thomomys uinta?*) are found in the Uinta region but are not reported from Colorado. This seems to indicate the plausible conclusion that the present Uinta mammal fauna has been derived from the adjacent territory to the north, and that the Green River canyon to the east forms an effective barrier in separating the Uinta mammals from those occurring in adjacent Colorado.

ANNOTATED LIST OF MAMMALS

Sorex palustris navigator (Baird).—Mountain Water Shrew. One specimen was taken July 24, 1928, on the edge of a small mountain stream tributary to Beaver Creek. This is in the pine belt[1] and at an altidude of 8,450 feet. Two others were reported seen on Sheep Creek by residents of this region. Jackson

[1] The zones, belts and habitat-types referred to here have been described in a paper now in press.

(1928, p. 188) lists this shrew from the Wasatch Mountains and the Uinta Forest—both west of this locality.

Euarctos americanus americanus (Pallas).—Black Bear. Bear tracks were found in Elk Park, a mountain park in the pine belt at 8,000 feet elevation, and also at Five Parks, which is in the upper part of this belt, at about 9,800 feet. Bears have become very scarce in this region but are occasionally reported in the forested parts of the range.

Ursus horribilis Ord.—Grizzly Bear. Powell (1875, Pt. I, p. 19 et seq.) reported grizzly bears in the mountain parks and pine forests of the region surrounding the Red Canyon of Green River. Barnes (1927, p. 29) states that A. W. Jensen reported a few in the Uinta Mountains in 1918. There have been no other recent reports of grizzlies.

Mustela vison energumenos (Bangs).—Mink. A mink skin was purchased from a storekeeper at Manila in 1928. The animal was said to have been trapped on the northern slope of the mountains. An adult with two half-grown young was seen on June 30, 1929, swimming down Sheep Creek, and two other adults were seen on Beaver Creek. Tracks were not uncommon on the mud flats of the latter creek.

Gulo luscus (Linnaeus).—Wolverine. Powell (1875, Pt. I, p. 19) reported wolverines in the Red Canyon country of Green River.

Lutra canadensis sonora (Rhoads).—Otter. Otters have been reported along Green River (Barnes, 1927, p. 46) but no recent reports were obtainable when the writer was in the region.

Spilogale sp.—Spotted skunk. Eber Gregory, a resident in this neighborhood, reported killing three little spotted skunks on Sheep Creek during the winter of 1928–1929. This seems the first record of the animals in the Uinta Mountain region. Cary (1917 p. 26) reported the Great Basin Spotted Skunk (*Spilogale gracilis saxatilis*) from the Upper Sonoran life zone of Wyoming. The type locality of this species is at Provo, Utah.

Mephitis hudsonica (Richardson).—Northern plains skunk. One specimen secured on Sheep Creek was identified by A. H. Howell. This is a new record for the state of Utah. Cary (1917, p. 34) reported the northern plains skunk from the Transition life zone of Wyoming.

Taxidea taxus taxus (Schreber).—Badger. An adult female was shot by the roadside in Wyoming, 9 miles north of Linwood, Utah, in the sagebrush plains region. A single skull was found in a dried-up stream bed on Green River at Hide Out, having evidently been washed down from the pine belt above.

Canis lestes lestes Merriam.—Coyote. Coyotes were found to range throughout the plains and the mountain slopes. Tracks and pellets were seen on the sagebrush plains north of Linwood; in the cedar-pinyon area at Hide Out on Green River; in the mountain parks of the pine belt; along trails in the spruce-fir belt; and even on the top of the Nipple. Coyotes sometimes follow the sheep herds and often do considerable damage, especially during "lambing" time. Poison is commonly used in combatting them. Often in the evening and early morning, coyotes were heard near camp. At Beaver Creek, two skulls and a specimen that had been poisoned were collected. In mid-afternoon on July 17, 1928, a female coyote with 4 half-grown pups was seen at Granite Park, in the upper part of the pine belt at about 9,000 feet. Another coyote was seen at

Beaver Creek, also in mid-afternoon, trotting unconcernedly through the park. Cattle were grazing nearby but they only raised their heads for a short time and then resumed their feeding.

Canis nubilus Say.—Gray wolf. Barnes (1927, p. 63) states that the 1925 estimate of the number of wolves in the Ashley National Forest was 5. No other recent reports were obtainable.

Felis oregonensis hippolestes (Merriam).—Mountain lion. During the summer of 1928, one was reported to have killed a few cattle at Dowd's Hole, which is in the pine belt of this region several miles east of Summit Springs. Powell (1875, p. 19 et seq.) mentioned mountain lions in the Red Canyon country. Barnes (1927, p. 67), quoting the 1925 estimate of mountain lions in the National Forests, lists 25 recorded for the Ashley Forest.

Lynx uinta Merriam.—Uinta wild cat. One skull of the Uinta wild cat was found at Carter Creek in the pine belt at 8,300 feet elevation. A skeleton was collected in the sagebrush plains just north of Linwood. These specimens were identified by Dr. H. H. T. Jackson.

Marmota flaviventris nosophora Howell.—Golden-mantled Marmot. This animal is abundant in the sagebrush parks of the pine belt where it occurs chiefly on the rock slides. It is found also in this type of habitat in the spruce-fir and alpine belts, but not nearly so commonly. Two specimens were taken at Beaver Creek and four at Carter Creek. Another was shot by the roadside in the pine belt some 30 miles north of Vernal.

Callospermophilus lateralis lateralis (Say).—Golden-mantled ground squirrel. These ground squirrels are common in the streamside type of habitat of the sagebrush belt; among the cedar-pinyons; and in the mountain parks of the pine belt, where they occupy the sagebrush and streamside types of habitats. Thirty-two specimens were taken at Sheep Creek, 2 at Elk Park, 1 west of Summit Springs, 1 at Carter Creek, 3 at Beaver Creek, and 2 at Granite Park.

Citellus armatus (Kennicott).—Uinta ground squirrel. These ground squirrels were plentiful in the streamside type of habitat beside Green River, 5 miles west of Green River City, Wyoming. Here 22 specimens were collected. In the sagebrush belt they are restricted to this habitat.

Cynomys leucurus leucurus Merriam.—White-tailed prairie dog. Prairie dog towns are common throughout the sagebrush type of habitat in the sagebrush belt wherever the soil is workable. In spite of annual poison raids, they persist in Lucerne Valley which is irrigated for agricultural purposes. Prairie dog holes are often found in and along the roadside from which they make inroads upon the adjacent alfalfa fields. At Manila, 8 specimens were collected, and at Linwood, 3.

Eutamias minimus minimus (Bachman).—Least chipmunk. The least chipmunk is restricted primarily to the streamside habitat-type of the sagebrush belt, although it is occasionally found near the adjacent rock cliffs. This subspecies is abundant along Green River, 5 miles west of Green River City, Wyoming, and 26 specimens were collected at this station. Along Henry's Fork at Linwood, Utah, 4 were taken, and just north of this station, by a rock cliff, one was captured. Those taken at the two places last named were distinctly more buffy in color and had slightly longer ears than the Green River form, exhibiting clearly an approach in characters to *Eutamias minimus consobrinus*. Howell (1929, p. 38) recorded specimens of *Eutamias minimus minimus* from Green River City,

Wyoming, and from 4 miles north of Linwood, Utah, and stated that this subspecies passes gradually into *Eutamias minimus consobrinus* in the foothill region of the Uinta Mountains.

Eutamias minimus consobrinus (Allen).—Wasatch chipmunk. This chipmunk was found in the streamside, sagebrush, rock slide and alpine types of habitat in the pine, spru cefir and alpine belts. Four specimens were taken at timberline on the Nipple, 1 at Beaver Creek, and 4 west of Summit Springs. At Sheep Creek, which is a mixed habitat and harbors certain species from both the sagebrush and the pine belts, 4 specimens were collected which approach *Eutamias minimus minimus* in characters.

Eutamias umbrinus (Allen).—Uinta chipmunk. The Uinta chipmunk ranges throughout the streamside, sagebrush, rock slide and alpine types of habitat in the pine, spruce-fir and alpine belts. It occupies the same types of habitat as the Wasatch chipmunk and can be distinguished from the latter by its longer ears. One specimen was taken at Sheep Creek; 10 west of Summit Springs; 8 at Beaver Creek; 1 at Granite Park; 2 at Beaver Dams at an elevation of 10,500 feet; and 3 on the Nipple at timberline.

Eutamias dorsalis utahensis Merriam.—Utah cliff chipmunk. This chipmunk is restricted to the rock cliffs, talus slopes and adjacent cedar-pinyon areas of the sagebrush belt. One specimen was taken a mile north of Linwood, 3 at Sheep Creek, and 1 at Hide Out.

Sciurus fremonti fremonti Audubon and Bachman.—Pine squirrel. The pine squirrel is a typical forest-restricted form and is abundant in the pine and spruce-fir forests of this region. Four specimens were obtained west of Summit Springs, 6 at Beaver Creek, 2 at Carter Creek, 2 at Granite Park, and 1 at Spirit Lake in the spruce-fir belt at 11,000 feet altitude. Pine squirrels were seen at Sheep Creek, where they come down into the lower altitudes along with other upper-belt species, for here their natural forest habitat is extended down along the creek-sides. The quick movements and scolding chatter of these squirrels come to be familiar and characteristic features of the forests.

Glaucomys sabrinus bangsi (Rhoads).—Flying squirrel. Flying squirrels, like pine squirrels, are typical forest animals. They are very elusive and apparently not abundant in this region. A family of three—an adult female, an immature female and an immature male were taken alive at Beaver Creek from a nest in a lodgepole pine tree on July 22, 1928. These were shipped to the Museum of Zoology, University of Michigan, for study. Another specimen was obtained at Granite Park. The only other specimens from Utah are six reported by Tanner (1927, p. 251) from Mt. Timpanogos. Barnes (1927, p. 99) reported that flying squirrels have been seen in the Wasatch Mountains by several people. Howell (1918, p. 31) stated that Allen recorded a specimen of this species from Smith's Fork, Uinta Mountains, but that the specimen has disappeared.

Thomomys pygmaeus Merriam.—Pygmy pocket gopher. This species of pocket gopher has not been reported before for the state of Utah, although Cary (1917, p. 34) found it in the Transition life zone of Wyoming. In the Uinta region it is confined to the flood plain banks of the streamsides where the soil can be easily worked. Four specimens were taken west of Summit Springs, 9 at Beaver Creek, 1 at Granite Park, and 9 at Sheep Creek. This animal was found chiefly in the pine belt, but comes down into the lower belt where a suitable habitat is provided along Sheep Creek.

Thomomys sp.—Pocket gopher. Pocket gopher runways were found in the alpine meadows on the Nipple. No specimens were obtained but they were believed to be *Thomomys uinta* on account of the altitude and from the fact that the type specimen of this form was taken on Gilbert Peak, in the Uinta range about 45 miles west of our locality.

Perognathus parvus clarus Goldman.—Uinta pocket mouse. The Uinta pocket mouse is restricted to the sagebrush type of habitat in the sagebrush belt. Two specimens were taken in the sagebrush plains region of Wyoming, 2 miles north of Linwood, Utah. E. A. Goldman has kindly identified these. Cary (1917, p. 34) reported this species from the Transition life zone of Wyoming.

Dipodomys sp.—Kangaroo rat. Tracks and holes of the kangaroo rat were found in the sandy areas of the sagebrush plains of Wyoming, north of Linwood, Utah. Cary (1917, p. 26) recorded *Perodipus* [*Dipodomys*] *ordii luteolus* from the Upper Sonoran life zone of Wyoming and this is most likely the species that occurs north of Linwood.

Castor canadensis frondator Mearns.—Beaver. Beaver dams, cuttings and houses are not uncommon along most of the mountain streams (pl. 11), showing that the beaver has been fairly widespread over this region. One skull was found at Beaver Creek, 3 at Granite Park, and 1 at Sheep Creek. Fresh tracks and cuttings were seen along Green River at Hide Out. In fact, in the evening, we occasionally heard the splash of beavers above the noise of the rushing water. Beavers are fairly well confined to the upper forested belts although they occur also in the sagebrush belt along the streams, where aspens, cottonwoods, and willows provide suitable food. At Beaver Creek, an adult and two young beavers were watched one evening as they worked upon a dam. The last few years have witnessed a severe reduction in the beaver population, judging by the abundance of old beaver dams and cuttings and the scarcity of fresh workings. Recent beaver signs were far less in evidence in this region during the summer of 1929 than during that of 1928. Along the streams of the mountain parks beaver dams have done much to increase the water content of the adjacent soil so that a luxuriant growth of grasses is maintained, rather than sagebrush. Where beaver dams have been broken for any length of time, the soil has dried out and sagebrush has encroached upon areas that formerly supported a rich growth of grasses.

Peromyscus crinitus auripectus (Allen).—Golden-breasted canyon mouse. This mouse is an inhabitant of the southwestern desert region and extends its range northward along the Green River. It is confined to the rocky cliffs and talus slopes of the canyons. Ten specimens were collected, 3 from north of Linwood and 7 from Sheep Creek. Two of the specimens from the former locality were captured alive and shipped to the Museum of Zoology, University of Michigan. The specimens from Sheep Creek were taken in 1928. Thorough trapping in the same locality in 1929 failed to reveal the presence of these mice. The severe winter of 1928–29 may have been the cause of this depletion. Although Cary (1917, p. 25) recorded this mouse from the Upper Sonoran life zone of Wyoming, this is the first time the canyon mouse has been collected in the Uinta region.

Peromyscus maniculatus osgoodi Mearns.—Osgood's white-footed deer mouse. According to Osgood (1909, pp. 73, 75–76), this subspecies is a plains and foothill-inhabiting form and in this region should intergrade with *Peromyscus manicu-*

latus rufinus of the mountains. Where we collected, *Peromyscus maniculatus osgoodi* was found to be a typical sagebrush inhabiting form which extended only as far up the mountain slope as the sagebrush, but no *Peromyscus maniculatus rufinus* or intergrades were taken. No species of *Peromyscus* occurred above 9,000 feet, at which altitude sagebrush gave way to shrubby cinquefoil in the mountain parks.

The different types of habitat in which these mice were collected included streamside, sagebrush, rock cliff, rock slide and the edges of the forests. The streamside and sagebrush types of habitat sheltered by far the greater number of these mice and proved more successful trapping places than the rock cliffs or rock slides. Although a few mice were caught at the edges of the lodgepole pine forest, never were they found to occur more than 100 feet in from the margins of the forest. In the yellow pine woods they were found wherever sagebrush occurred as undergrowth. In 1929, mice were less plentiful along Sheep Creek than in 1928. This may have been due to the severe winter of 1928–29. A total of 263 specimens were taken, besides a stock of 33 live mice from different localities. The live mice were shipped to the Museum of Zoology, University of Michigan, for breeding stock in a study of distributional variation carried on by Dr. L. R. Dice.

Peromyscus boylei rowleyi (Allen).—Rowley's cliff mouse. Like the golden-breasted canyon mouse, this species characterizes the southwestern desert region and has evidently extended its range up along Green River. Its type locality is in San Juan County in southeastern Utah. Only two specimens were collected. Both were taken at the base of a rock cliff at Hide Out on Green River. This is the northernmost record for the species.

Neotoma cinerea orolestes (Merriam).—Bushy-tailed wood rat. This wood rat is a characteristic animal of the western mountain regions. It is primarily restricted to the rock cliff and rock slide types of habitat but is often found in buildings. Nineteen specimens were collected: 7 north of Linwood; 1 at Hide Out; 5 on Beaver Creek; 5 on Carter Creek; and 1 in Granite Park. Three of the 7 collected north of Linwood were taken alive and sent to the Museum of Zoology, Universi y of Michigan.

Clethrionomys gapperi galei (Merriam).—Red-backed vole. One specimen of this vole was caught by the streamside at Beaver Dams, which is in the spruce-fir forest belt at an altitude of 10,500 feet. This is evidently a new record for the Uinta Mountains although Bailey (1897, p. 127) stated that "a badly mutilated skin in the National Museum from the Uinta Mountains, Wyoming, ought on geographic grounds to belong to this species." Cary (1917, p. 43) reported the species from the Canadian life zone of Wyoming.

Microtus nanus nanus (Merriam).—Dwarf vole. One specimen of the dwarf vole was captured at Henry's Fork, in a streamside type of habitat in the sagebrush belt. This form is described by Bailey (1900, p. 30) as belonging to "dry, grassy parks on mountain slopes" and rarely found "in wet places or near water." It is to be supposed that this species has found its way down from the mountain slopes along Henry's Fork.

Microtus mordax mordax (Merriam).—Rocky Mountain vole. This vole was collected along the streamsides in the pine belt. It was found to occur also along Sheep Creek, which is in the sagebrush belt. One specimen was taken at Sheep Creek, 2 west of Summit Springs, 5 at Beaver Creek, 1 at Carter Creek, and 3 at Granite Park.

Ondatra zibethica osoyoosensis (Lord).—Rocky mountain muskrat. The muskrat is restricted to the streamside type of habitat, regardless of the vegetation belt. Two specimens were taken at Spirit Lake. Muskrat tracks were seen in the mud flats along Sheep Creek, and houses and runways were not uncommon in the marshy places along Henry's Fork. Several muskrats were watched at Beaver Creek one evening as they swam across a beaver pond to a marshy area where they gathered sedges and grasses and returned with these in their mouths. Their house was built up on the side of an old beaver house situated in the middle of the pond.

Zapus princeps princeps Allen.—Rocky Mountain Jumping mouse. Jumping mice were found to occur among the willows (*Salix geyeriana* Anderss.) which grow in patches along the streams of the pine belt in mountain parks. Two specimens were collected at Elk Park, 9 at Beaver Creek, 4 at Carter Creek, and 1 at Granite Park. This is the first time the jumping mouse has been recorded from the Uinta Mountains. It has been reported only twice before from Utah (Wolfe, 1928, p. 154 and Moore, 1928, p. 154).

Erethizon epixanthum epixanthum Brandt.—Yellow-haired porcupine. Porcupines are restricted primarily to forest habitats. Although they occur more commonly on the forested mountain slope, they often come down along the canyons into the sagebrush belt where coniferous trees provide suitable food and shelter. They are found also in the minor belt of cedar-pinyons. One specimen was collected at Carter Creek, 1 at Long's Park in the pine belt, and 2 at Sheep Creek. Pinyon pines gnawed by porcupines were seen in the cedar-pinyon area near Hide Out. Gnawed spruce trees were observed also in the spruce-fir belt above Beaver Dams. Local rangers are prone to kill porcupines on sight on account of the damage they think these animals do to the forest trees.

Ochotona princeps uinta Hollister.—Uinta pika. The pika is restricted to the rock slide type of habitat of the three upper belts. The lowest elevation at which this animal was taken was 9,000 feet, two specimens being collected at Granite Park. One was taken on a rock slide at Spirit Lake, and 19 were secured at and above timberline on the Nipple. At this station, they appeared to be more abundant during the summer of 1929 than during that of 1928. During the first part of August, these little animals were busy curing and storing hay for the winter. Many fresh hay piles were found among the rocks. The hay consisted chiefly of *Sieversia turbinata*, mixed with thistle, *Carduus lanceolatus*, and clover, *Trifolium parryi*.

Lepus townsendii townsendii Bachman.—White-tailed jack rabbit. Jack rabbits were seen along the roadside on the sagebrush plains north of Linwood. They were not uncommon here during the summer of 1928 but only a few were seen in 1929. The severe winter may have been the cause of this seeming depletion in numbers. Jack rabbits were seen also in the cedar-pinyon foothills, and they undoubtedly range up into the mountain parks of the pine belt.

Lepus bairdii bairdii Hayden.—Snowshoe hare. The snowshoe hare ranges through the parks, streamsides and forests of the pine and spruce-fir belts and often forages in the alpine meadows. Two specimens were collected, one at Carter Creek and one at Granite Park. Pellets were common in the mountain parks, along trails and in the alpine meadows.

Sylvilagus nuttalli grangeri (Allen).—Cottontail rabbit. This cottontail is

found along streamsides and adjacent sagebrush in the sagebrush belt. Several were seen at Sheep Creek, usually about dusk, and 2 were collected at this station. One that was shot had been feeding on sagebrush and still had leaves in its mouth.

Cervus canadensis canadensis (Erxleben).—Elk. Judging from Powell's reports (1875, p. 19) and Indian petroglyph records (pl. 11), as well as from reports of some of the older residents, elk were formerly abundant in this region. Although they are now protected by law, there are comparatively few left in the mountains. Two does and a calf were killed out of season, supposedly by Indians, during the summer of 1928. The skulls of these animals were obtained for specimens. Tracks and droppings were common in the mountain parks, along trails and in the alpine meadows. Towards dusk one evening an elk was surprised on a mountain trail in the spruce-fir forest, and just enough of its back was seen to identify it before it crashed off through the timber.

Odocoileus hemionus hemionus (Rafinesque).—Mule-deer. Mule-deer are not uncommon in the mountain region but cannot compare in numbers with those reported by Powell (1875, p. 39) who recorded them as occurring in herds. A skull was secured at Granite Park. Shed antlers were found at Sheep Creek and Beaver Creek, and fresh tracks were seen at Hide Out and on the Nipple. A young buck was seen at Granite Park one evening only a few hundred feet from camp.

Antilocapra americana americana (Ord.)—Pronghorn antelope. An antelope was reported seen on the sagebrush plains north of Linwood during the summer of 1929. Powell (1875, p. 40) recorded antelope on the plains near Split Mountain Canyon which is farther east and south on the Green River. These animals are now very scarce throughout this country. The few that are occasionally seen are usually wanderers from the protected herds of Wyoming.

Bison bison bison (Linnaeus).—Plains bison. Bison bones were found above timberline on the Nipple at an altitude of approximately 11,800 feet. These included a much weathered, incomplete skull, one odd horn, a few teeth, and an astragalus and a calcaneum. Fryxell (1926, pp. 102–109) discussed altitudinal limits of the American bison and recorded his highest find of a skeleton at 11,700 feet. He quoted Hornaday as regarding any records above 7,000 feet as indicating that the bison were wandering for food or migrating.

Ovis canadensis canadensis Shaw.—Mountain sheep. No recent reports of mountain sheep were obtained during the time the writer was in this region, although Indian petroglyphs (pl. 11) indicate that these animals were former inhabitants here. Powell (1875, pp. 32–33) recorded them from Echo Rock near the mouth of the Yampa River. Sheep Creek, according to the old-time residents of the country, was named from the mountain sheep which were once plentiful there.

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MAMMALS OF HAMPSHIRE COUNTY, MASSACHUSETTS

By Jocelyn Crane

The mammals of Massachusetts have received so far comparatively little attention. The first organized attempt to list them was Hitchcock's list, published in the State Report on the Geology, Botany, and Zoology of Massachusetts in 1831, followed nine years later by Emmons' report. Almost thirty years later, in 1869, the list by J. A. Allen appeared; this author, however, was more interested in the demarkation of species than in abundance and local distribution. A gap of nearly forty-five years then ensued until C. E. Brown published, in 1913, a "Pocket List of Mammals of Eastern Massachusetts." Meanwhile some species had become rare or had disappeared entirely, even in western Massachusetts, the last stronghold in the state for some of the vanishing forms. For over sixty years the subject has not been studied locally west of Worcester and during this period many changes have taken place in the mammalian fauna. The present study covers a representative area in the western part of the state.

My thanks are due to a great many people, ranging from game commissioners and museum curators to trappers, all of whom rendered invaluable help in this investigation. To Dr. E. C. Driver of Smith College, under whose direction this study was made, I am especially grateful, as well as to the following; Dr. William Beebe, Dr. G. M. Allen, Mr. David A. Aylward, Mrs. Estelle Crane, Mr. H. H. Chilson and Col. W. J. Collins.

Hampshire County is a typical inland New England habitat area, with meadows, fields, and woodlands in great variety; streams both large and small, and wild unsettled districts, in which vanishing species still find a foothold, lying but a few miles from thickly populated towns. The total area of the county is 600 square miles, with a population, in 1925, of 75,122. The chief agricultural products are onions, tobacco, hay, and some corn.

The elevation varies from 200 feet in the broad meadows bordering the Connecticut River to 1400 feet in the hilly regions in the western part of the county. There is thus enough difference in elevation to permit the presence of forms of life suited to either lowlands or highlands, yet the altitudes are not great enough to support actual Canadian forms, such as are found to the westward in the Berkshires. In fact, this part of Massachusetts lies in an especially interesting portion of the

Transition Zone, for it is more or less neutral ground where both typically northern and typically southern species are found side by side.

Didelphis virginiana virginiana Kerr.—Virginia Opossum. Very rare. The opossum is included only as a straggler, since the county lies far beyond its normal range. Nevertheless, it seems that it must be extending its range, since it has been reported even from New Hampshire, (Kennard, Jour. Mamm., 1925). A specimen in the Boston Museum of Natural History was taken in Newton Center, Mass, in 1925, another was taken in Amherst about 1929, and one just outside Northampton in 1929.

Blarina brevicauda talpoides Gapper. Short-tailed Shrew. Abundant. The short-tailed shrew is one of the most common of our local small animals, and is found in all sorts of environments, ranging from damp meadows to dry wooded hillsides, in fact, wherever insects and mice are present. I met numerous people, however, who had never even heard of a shrew, apparently always mistaking it for a mouse. Even Emmons, in 1840, said, "The species is retained on the authority of former catalogues—I have not been able to meet with it and have some doubts of its existence within the limits of the state." On several occasions I have found in a trap the neatly scraped skin of a white-footed mouse, turned inside out, indicating that a shrew had reached the trap before me.

Parascalops breweri Bachman.—Rather uncommon. A few specimens have been taken in the vicinity of Smith College.

Condylura cristata (Linnaeus).—Star-nosed Mole. Fairly common.

Mustela cicognanii cicognanii Bonaparte.—Bonaparte's weasel; ferret; stoat. Common. Next to the skunk, Bonaparte's weasel is the most abundant of our carnivores, although so quick in its movements and unobstrusive in its ways that it is seldom seen.

Mustela vison mink (Peale and Beauvois).—Mink. Fairly common. The mink seems to be holding its own in this region. It is not listed in the early books, but Emmons, 1840, and Allen, 1869, record it as common.

Lutra canadensis canadensis (Schreber).—Otter. Rather rare. The otter is now much rarer than in the early days, although at present, because of the protection it receives, combined with its natural wariness, it seems to be holding its own. In Josselyn's "Two Voyages," 1675, it is recorded as "very numerous." In 1869 Allen said of it, "not rare, still not often captured; at Springfield I have known some half-dozen specimens taken in the past ten years." In 1926, but 22 were reported trapped in the entire state; in 1927, 35, and in 1928, 33.

Mephitis nigra (Peale and Beauvois).—Eastern Skunk. Very common. The skunk is the most abundant of our carnivores, and is found wherever there is a suitable place for a den. According to Judd, 1863, they were once scarce in New England, but increased rapidly as the land was settled and their insect food became more abundant.

Vulpes fulva (Desmarest).—Red fox. Common. The red fox is in no danger of losing ground at present. Farmers, trappers, hunters, and game wardens all agree in listing it as one of the commonest of the larger animals of the county. Trappers returns for the past few years are: 1926, 1869 foxes taken in the state; 1927, 2411; 1928, 2023.

Massachusetts offers the fox no protection whatever, although over half of the other states provide some sort of closed season on it.

Urocyon cinereoargenteus borealis Merriam.—Northern Gray fox. Common. The gray fox appears to be somewhat less common than the red fox in this region. This may be due to the fact that it prefers the deeper woods, and so is less often seen. Also, since its fur is much less valuable it is not systematically hunted. There is a fine specimen from Easthampton in the Boston Museum of Natural History. The Springfield Museum has one from Tolland, Hampden County.

Canis lycaon Schreber.—Eastern timber wolf. Although the wolf is almost extinct in the county, and, indeed in the greater part of New England, there are occasional stragglers to remind one of the day when the wolves were the greatest pest the farmers knew.

From the time of the earliest settlement of the country in the seventeenth century until about a hundred and fifty years ago these animals were perhaps the greatest single pest with which the raisers of livestock had to contend. In the Records of the Governor and Company of Massachusetts in New England for 1630 we find the following regulation—the first I find in regard to any sort of bounty on any American animal: "It is ordered, that eny Englishe Man that Killeth a Wolfe in eny Pts within the Lymitts of his Pattent shall have allowed him 1d. for eny Beast and Horse, and 5d. for eny weaned Swyne and Goate in eny Plantations, to be levied by the Constable of the Se Plantations."

After the beginning of the eighteenth century wolves, although still a decided nuisance, became much scarcer, in spite of Wood's prophecy in the preceding century that "there be little hope of their utter destruction, the county being so spacious and they so numerous" (New England's Prospect, 1634). However, in the first thirty-seven years of the century bounties were paid by the county on 2852 grown wolves and 191 whelps (Judd, 1863), while in 1772, to encourage sheep-raising in the west, the state bounty was raised to four pounds. In the town of Northampton four full grown wolves were killed that year. By 1805 they had become so rare that the hunting of a pair which had been doing much damage in the Amherst-Hadley region was regarded as great sport. Hitchcock (1831) and Emmons (1840) mention the wolf in their lists but make no comments on their abundance. Since 1870 they have been practically extinct, although "Wolf Hills" and "Wolf Creeks" serve as a reminder of their former abundance, and "Wolf Pit Swamp" near Northampton preserves the memory of the city wolf trap.

Lynx rufus rufus (Schreber).—Bay lynx; bobcat. Fairly common. This animal has been increasing throughout New England in recent years, following a long period of relative scarcity. As early as 1727 the Province offered, for about ten years, a reward of twenty shillings for each adult wild cat killed. In 1903 the state again found it advisable to establish a bounty of five dollars for the killing of "a wild cat or Canada lynx or loupcervier," which, in 1925, was raised to ten dollars. Since the act went into effect the average numbers of bounties paid annually in Hampshire County have been: 1903–1909, 5.3; 1910–1919, 7.4; 1920–1929, 8.4.

Lynx canadensis canadensis (Kerr).—Canada lynx. Very rare. Emmons wrote in 1840: "It was once common in the State, but appears now only in the depth of winter, and as a straggler."

In the latter part of February, 1930, two "cats," one supposedly a Canada lynx, were killed near Easthampton. The skins had been disposed of before I could examine them but I did see some fairly good photographs of the animals taken immediately after they were killed. The specimen in question had the exceedingly short tail of the lynx, and prominent ear-tufts. The feet were, unfortunately, indistinct. The animal weighed 24 pounds.

In the early fall of 1923 two animals, reported to be young Canada lynxes, were trapped on Breakneck Mountain, a particularly wild district near Huntington in this county. If this report is reliable it would indicate that the animals were breeding there, since it is unlikely that they would stray so far from their usual northern haunts at that season of the year.

Felis couguar Kerr.—Mountain Lion, Cougar. Practically extinct. Although the Adirondack cougar is generally considered extinct in this state I have one record of its recent appearance in the mountainous country around Huntington, Hampshire County. The Reverend Mr. J. Chapin tells me that on January 18, 1926, he had a good view of an animal, undeniably a cougar, as evidenced by the cat-like form, the size, the color, and the *very long tail*. Dogs set upon the trail refused to follow it. The following morning the animal was seen by a neighbor. Tracks have been seen since at wide intervals, but a specimen has not yet been taken. Cougars were undoubtedly once more or less common in New England. John Josselyn refers to occasional "lyons" seen on Cape Ann and killed by the Indians. Wood, 1634, mentions "Plimouth Men" hunting for "lyon skins." One was killed by Northampton hunters in 1764, at which time a bounty of four pounds was in force, which bounty would indicate that they were still numerous enough to cause some apprehension.

C. F. Jackson, 1922, (Jour. of Mammalogy, Vol. 3) records that for five preceding years a pair of cougars had ranged along the Androscoggin River in New Hampshire. Their best and last stronghold was in the Adirondacks, so that their appearance in Massachusetts is quite believable.

Procyon lotor lotor (Linnaeus).—Raccoon. Common. For the last few years, since it has had real legal protection, the raccoon has been holding its own, although before that it had been becoming increasingly rare. In 1869 Allen described it as formerly numerous, and still common in the unsettled and mountainous parts of the state. It does not confine itself to those parts today, but is frequently encountered in the broad meadows along the Connecticut River where it carries on its fishing operations.

Myotis lucifugus lucifugus (LeConte).—Little brown bat. The most common of the local bats.

Eptesicus fuscus fuscus (Beauvois).—Big brown bat. Common.

Lasiurus cinereus (Beauvois).—Hoary bat. Very rare. The only specimen from this county of which I have actual record is in the Smith College museum.

Lasiurus borealis borealis (Müller).—Red bat. Not common.

Sciurus carolinensis leucotis (Gapper).—Northern gray squirrel. The gray squirrel occurs in numbers only in small areas. In the early days it was so numerous as to be considered a pest and in 1740 Massachusetts offered a bounty of four pence for "water-rats, gray, and ground squirrels." It appears to have maintained its numbers until about twenty years ago when the dying out of the chestnut trees led almost to its extinction. Since then it has become re-established in scattered areas.

Sciurus hudsonicus loquax Bangs.—Red squirrel; chickaree. Common.

Tamias striatus lysteri (Richardson).—Chipmunk. Common. The chipmunk seems to be holding its own, during the last twenty years, at least. It cannot, however, be termed "abundant," as Allen characterized it in 1869. Although it is one of the truly hibernating animals the author trapped a specimen as early as March 7, in 1930.

Glaucomys volans volans (Linn.).—Eastern flying squirrel. Common, although by reason of its forest-loving and nocturnal habits it is seldom seen. It keeps largely within the comparatively small patches of "big timber" which are scattered throughout the county.

Marmota monax preblorum Howell.—Woodchuck. Abundant. The burrows of the woodchuck are found everywhere on sunny hillside pastures and in open meadows. However, Judd (1863) says that they were very rare when the country was first settled, and only when the land was cleared more to their liking did they become numerous. By 1840 Emmons lists them as common. In this region they do little damage, since the chief crops, tobacco and onions, do not appeal to them. Their burrows in hayfields are a menace to horses, however.

Mus musculus musculus Linn.—House mouse. Abundant.

Rattus rattus rattus (Linn.).—Black rat. Very rare. A specimen of the black rat, taken at Amherst, in 1915, is in the Smith College museum. Emmons, 1840, said that it was numerous around the Williamstown sawmill, but that was the only place where he found it. Allen, 1869, described it as abundant in farming districts, but rare wherever the brown rat was found. Miller, 1900, says, "This animal still occurs in central Massachusetts, but with this exception I know of no localities where it is now found abundantly in the northeastern United States."

Rattus norvegicus (Erxleben).—Norway, gray, or common rat. Abundant.

Microtus pennsylvanicus pennsylvanicus (Ord.).—Field mouse, Vole. Abundant. The meadow mouse, although abundant, was not taken as often as the white-footed mouse and the short-tailed shrew. Specimens were taken most frequently on the uncultivated brushy edges of fields and never in wooded districts.

The species was listed by Hitchcock, 1831, with a question mark, but that it was really extremely rare then seems unlikely. That author, like most of the people of his time, may have been rather unobservant of the smaller mammals.

Pitymys pinetorum scalopsoides (Audubon and Bachman).—Pine mouse. Very rare. The only record I have of this species occurring in this county, or even in western Massachusetts, is that of a specimen from Northampton now in the Smith College Museum. Allen, 1869, recorded the capture of two specimens near Springfield.

Peromyscus leucopus noveboracensis (Fischer).—White-footed deer mouse. Abundant. With the short-tailed shrew, the white-footed mouse is locally the most abundant of our small mammals. Therefore it seems strange that as late as a hundred years ago, when the country was well settled, Hitchcock, 1831, notes the species with a question mark and Emmons, 1840, lists it as a new species under the name of *Arvicola emmonsii*.

Ondatra zibethica zibethica (Linn.).—Muskrat. Abundant. Thanks to the measures which have been taken to protect it during the past ten years the muskrat is again abundant. In the state at large trappers reports to the Game Commissioner indicate that it is still on the increase.

Zapus hudsonius hudsonius (Zimmerman).—Jumping mouse. Rare. A single specimen, taken in Northampton and preserved in Smith College Museum is the only reliable record I have of its occurrence in the county.

Erethizon dorsatum dorsatum (Linn.).—Porcupine. Fairly common. The porcupine is apparently on the increase. Audubon and Bachman, 1849, say that the animal was rare in the north-eastern states, and Emmons, 1840, says "although it is common on the mountains in the vicinity of Williamstown I have never even heard of it in any of the neighboring towns." Allen, 1869, lists it as occasional on the Hoosac ranges. In this section it is becoming quite a pest because of its habit of girdling hemlock and other valuable trees.

Lepus americanus virginianus (Harlan).—Snow-shoe rabbit. Fairly common. The snow-shoe hares are less common locally than are the cottontails. All the older authorities have said that they were plentiful in Massachusetts, although Stone and Cram, 1905, say that the cottontails have driven them out of at least part of their range. Because of their popularity as game they have long been protected in this state, the first act being passed in 1835.

Sylvilagus transitionalis (Bangs).—New England cottontail. Common. The cottontail is about twice as common as the snow-shoe rabbit, and is more widespread. The animal is nowhere so plentiful as to be of serious damage to crops, nor is it rare enough to justify the importation of others for the benefit of sportsmen, as is being done in other parts of New England. The present legal protection seems quite satisfactory.

Odocoileus virginianus borealis (Miller).—Virginia deer. Common. The history of the Virginia deer in New England inevitably calls to mind that of the beaver: both were numerous through the seventeenth and the first half of the eighteenth centuries; both were veritable staves of life to Indians and pioneers; both, because of ceaseless hunting and the cutting of the woodlands, became rare and almost extinct, except in the wilder regions of Maine. Unlike the beaver, the deer received, before it was too late, a chance to regain its stand. This chance was due to a combination of two factors. The first was legal protection. The second, pointed out by Dr. G. M. Allen in his splendid "History of the Virginia deer in New England," 1928, was that after the Civil War, with the immense spread of manufacturing, great numbers of the country people moved to the towns to work, so that great stretches of abandoned farms gave the deer most of the benefits of modern game preserves. By the time an economic balance was re-established, and some of the discouraged people returned to the farms, wise laws were in effect to give the protection to which the deer have so markedly responded.

Alces americana americana (Clinton).—Moose. The moose has been practically extinct in Massachusetts since about the beginning of the 19th century, but occasional stragglers have been reported in the more mountainous and unsettled regions. One was reported last year, and another was killed in Berkshire county, contrary to law, since the legislature in 1913 declared a perpetually closed season on moose.

SUMMARY

In Hampshire County of western Massachusetts, settled by the English in about 1650, and where silk and cotton mills abound and pulp mills and saw mills are found along the edge of most of the wooded hills, thirty six species of mam-

mals still exist. Of these, three are almost extinct, five are very rare and most of the others are fairly abundant. Of the almost extinct and very rare species all save two—the otter and the black rat—have always been uncommon so that it is not a question of their having been driven out by recent causes. In a number of cases some species, both among those that are receiving legal protection and those that are not, as the bobcat and the porcupine, are actually increasing. The nearness of large industrial towns seems to have little effect upon the variety or numbers of the mammals found, as long as rocky timbered hills afford them suitable retreats and breeding grounds.

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A PLEISTOCENE FAUNA FROM SOUTHERN NEBRASKA

By Harold J. Cook

Through co-operation with Director A. M. Brooking of the Hastings Museum, Hastings, Nebraska, the writer has been enabled to study some important early Pleistocene mammal remains which throw additional light on the history of those times in this country.

The writer visited the region in September, 1928, and made a hurried examination of the territory, but did not have the time necessary to work out the geology in detail. In general, the deposits observed appear to belong to Nebraskan and Kansan deposits, some of the evidence suggesting Aftonian. But as local deposits and channels abound, its story is not simple. Owing to the lack of continuity of exposures, and the general presence of late deposits and soils blanketing most of the region, and the irregularity of deposits, the problems are further complicated, and much careful work is needed to decipher accurately the history written here in glacial and interglacial times.

The specimens noted herein are from various spots within a radius of some thirty miles from Hastings, and are all from this series of beds. It is hoped that careful work may be done here later on, to amplify this record and obtain more exact data on the beds and the age of these fossils. It seems probable that the fauna listed below may not all have been a contemporaneous one, but may represent phases of transitional climatic conditions.

LIST OF THE MAMMAL FAUNA

Elephas cf. primigenius
Canid, gen. et sp. indet.
Taxidea cf. taxus
Equus complicatus
Equus niobrarensis
Bison latifrons Harlan
Symbos tyrrelli Osgood
Cervalces roosevelti Hay
Megatherium, sp.
Camelops?, sp.

Elephas cf. primigenius

Among the specimens examined through the coöperation of Director Brooking is a fragmentary mammoth skeleton, collected about 25 miles southeast of Hastings, Nebraska. Much more of the skeleton was originally present, but curiosity of local people prompted excavating, with the usual consequent destruction. A few vertebrae, ribs, limb bones, and a broken upper molar are present, but the fairly complete lower jaws are best preserved.

These jaws are very short, and the front of the symphysis points downward, almost at right angles to the wearing surface of the molars. The molars are narrow, and have seventeen plates, closer together toward the rear of the tooth, and wider spaced forward; so that a count of the number of plates per 100 mm. ranges from 7 to 9, averaging 8. The typical *E. primigenius* has 19 plates in the lower molars, and 10 plates to the 100 mm.

In the right ramus, in addition to M_6, M_5 is also present, and has 4 plates preserved. The left jaw had apparently shed this tooth, and M_6 had migrated somewhat forward in the jaw. The molars are notably narrow, in relation to those seen in most "mammoths" of this size.

In general, this specimen agrees fairly closely with *E. primigenius*, and its characters suggest the possibility of its being an early member of that family. However, in view of the fact that Professor Henry Fairfield Osborn is at this time approaching the completion of his monumental revision of all known proboscideans, it seems best to withhold more detailed studies of this specimen until this work is available for reference.

Measurements (in millimeters)

Length of jaw, back of ascending ramus to front of symphysis	438a[1]
Distance tips of rami are depressed at right angles below alveolar border	235
Greatest length of M_6	240
Greatest width of M_6	73
Length of M_5	62
Width of M_5	60
Greagest depth of jaw under middle of M_6	145
Greatest width of jaw under middle of M_6	145

[1] Note: The letter "a," after a number, denotes an approximate measurement.

Taxidea cf. taxus

A virtually complete, undistorted and articulated skull with jaws was found in Pleistocene gravels about 2 miles northeast of Spring Ranch, on Pawnee Creek, about 25 miles northeast of Hastings. The skull was in nearly perfect condition when found, and the four front teeth that are slightly damaged on one side are perfect on the other, so that no characters are lost. The skull is from an adult animal of very robust proportions. The bone is fossil, toughened readily with thin shellac, and has marked impregnation by manganese dendrite.

The species is closely allied to the modern badger, and is even heavier than the Colorado form, *T. taxus phippsi*. As compared with the type specimen of that

variety, it shows heavier, more rugose and larger development throughout. The canine teeth are larger and heavier, and M^1 is somewhat smaller and simpler in pattern. The tympanic bullae are even more expanded than in the modern badger, actually extending around and in front of the inner end of the postglenoid process. The teeth are just beginning to show wear, yet, as one compares this skull part for part with various skulls of the modern badger, the heavy development and sturdy build of this animal is constantly emphasized. This is notable in the high, strongly developed occipital crest; the size and sturdiness of the coronoid processes of the jaws; and of all areas of heavy muscular attachment.

The exact age of the gravels in which this specimen was found is not determined; but it apparently belongs to the same gravel series in which most other fossils are found here. It remains for future work to determine the relations of the beds here represented, but all appear to be early Pleistocene. This badger, however, shows less variation from modern species than the balance of the fauna noted, and the deposit in which it was found may prove to be a later channel, developed by some stream of later Pleistocene times, which has reworked the older gravels in this spot. The occurrence of this deposit, however, is such as to preclude the possibility of its being a recent re-deposition.

Measurements of skull (in millimeters)

	Hastings badger	*T. taxus phippsi* Type
Greatest length of skull	131	131
Breadth back of postorbital process of frontals	34	26
Breadth of palatines	20	14
Breadth across zygomatic arches	90	81
Breadth between paroccipital processes	47	42
Breadth of skull at infraorbital foramen	36	33
Depth of skull from base of condyles to occipital crest	46	41
Antero-posterior diameter of canine	8	6
Transverse diameter of canine	6	5
Antero-posterior diameter of M^3	10	13
Transverse diameter of M^3	8	11

Bison latifrons Harlan

A brief survey of the history of the discovery and naming of this classic species brings out many points of interest.

In The Philosophical Magazine, in 1803, was published an article by Rembrandt Peale entitled, "Account of Some Remains of a Species of Gigantic Oxen found in America and other Parts of the World," describing and figuring part of an immense skull, the first fossil bison skull to be described from America. This had been found some twelve miles from Big Bone Lick, Kentucky, in the bed of a small creek; and presented to the American Philosophical Society by Dr. Samuel Brown. Since that time it has been examined and described by a large number of scientists both from America and Europe.

In 1825 this specimen was used as the type of *Bos latifrons*, by Dr. Richard Harlan, who believed it related to, but specifically distinct from, the aurochs of Europe. This description formed the first systematic name that any of the ex-

tinct bisons received. Later Dr. Joseph Leidy recognized its true relationships and referred it to the genus *Bison*, which genus had been originally proposed as a subgenus of *Bos* by Hamilton Smith, in 1827, and had been raised to full generic rank in 1850 by Turner. Several incomplete specimens have been referred to this species since then, some of which appear to be valid references, while others are definitely or probably in error.

In the collection at Hastings Museum is a very fine specimen consisting of the posterior half of the skull and horn-cores of a large specimen of *B. latifrons*, in which the preservation is nearly perfect. This is one of the finest known specimens of this imposing bison, and adds another locality to the range of its known occurrence and distribution. The specimen was chopped into by the shovels and picks of gravel haulers who found it, and was damaged by them to some extent; but fortunately it was so hard and well fossilized that it largely resisted their assaults.

Comparison with Leidy's figures and measurements of the classic type specimen in Philadelphia shows numerous differences, and it is not at all unlikely that if more complete materials are found for comparison, it may be found that specific differences are present. On the other hand, we know little of the range of individual variation in this species, and, in the writer's opinion, it is better to consider these differences as such, at least for the present. These horn-cores are nearly round, very massive, but little curved, and rise sharply upward at an angle of nearly forty degrees from a line drawn across the skull at the back of the orbits. The specimen was from an old bull.

Since the above was written Director Brooking has secured a second splendid bison specimen from the vicinity of Hastings, which was forwarded to the writer for identification. This specimen is complete from the orbits back, save for the tips of the horn-cores; and is neither crushed nor distorted. This specimen is here provisionally referred to *B. latifrons*, but it shows certain characters in which it approaches other described species, and differs not only from the other skull described herein, but from the typical *B. latifrons*. The horns are relatively longer and more slender than in the latter, and the head relatively narrower between the bases of the horn-cores, agreeing more nearly in these characters with *B. regius*, but differing from both this species and *B. alleni* in having straighter, less curved horns, and more like *B. latifrons*. Likewise, the angle at which the horns leave the head differs in a marked degree in these forms. In this last specimen, the horns grew out sideways more nearly at right angles to the perpendicular axis of the skull than in any of the other forms mentioned, and rise only about 17° from a line connecting the bases of the horn cores; as compared with the first set of horns which rise sharply at an angle of 40°.

The writer has noted that this angle varies as an age character in the modern *B. bison*, the horns being straighter and lower in young bulls, and curving and rising higher and backward with age. But as between these two specimens from near Hastings, there appears to be little difference in age, both being adult males, so this is hardly an explanation of these differences. This last Hastings specimen is very close in type, in some characters, to the specimen found in Hungary and figured by Dr. H. von Meyer, under the name of "*B. priscus*," but has relatively longer horns. As to the length of horns, however, it is well to recall that this differs widely in modern bisons, and may have differed equally in extinct races.

It may well be that some of the diverse types of *Bison* skulls, listed from Europe under the general name of "*B. priscus*," in reality represent relatives of the divergent bison stocks which also migrated to America, and presumably from an Asiatic center of dispersal, during Pleistocene times.

Measurements (in millimeters)

	Bison lati-frons Nebr. No. 1	*B. lati-frons.* Type	Nebr. Skull No. 2
Diameter of base of horn cores, fore and aft	147		130
Diameter of base of horn cores, vertical	160		141
Circumference of horn cores at base	484	520	420
Length of horn cores on outer curve	825		786
Length of horn cores on inner curve	780		810
Circumference of horn, 14 inches from base	360	450	314
Distance between tips of horn cores	1562		1670
Index of horn curvature[1]	113		110
Index of horn proportion[2]	57		51
Shortest distance between tip of horn-core and its base	730		715[a]
Width between bases of horn cores across forehead	330	380	360
Width at constriction between bases of horn-cores and orbits	360		347
Width of skull at rear of orbits	412		380
Width of skull at auditory apertures	308		324
Width at foramen magnum	46		53
Width of occipital condyles	152		154
Height of occip. crest above base of occip. condyles	197		182
Height of occip. crest above upper edge of foramen magnum	144	140	122
Diameter of orbit (approximate)	90		
Distance from middle of occip. crest to middle of line joining orbits	280		260
Distance from lower border of foramen magnum to fronto-nasal suture ("basi-nasal length")	307		302

a = approximate.

[1] Index of horn curvature: The shortest distance between the tip of the horn-core and its base is made 100. The relation of this to the length along the outer curve is then determined.

[2] Index of horn proportion: The length of the horn along the outer curve is made equal to 100. The relation of this to the circumference at the base is then determined.

Symbos tyrrelli Osgood

A posterior half of a skull, with horn-cores, found near Spring Ranch, in the vicinity of Hastings, is referred to this species. This is an interesting specimen of an adult animal, and is exceptionally hard and well preserved, as far as present, and is thoroughly mineralized. It has clearly marked affinities to the well known species, *Symbos cavifrons*, Leidy, but exhibits certain marked differences which appear to have greater range than is to be expected in individual variation. Unless the males and females of this race were much more alike in skull and horn development, than in *Ovibos*, this is the skull of a male; and, though the skull measurements of the type of *S. cavifrons* and this specimen agree closely in certain details, as in the width at mastoid region and the width at rear of orbits, yet they differ widely in others. For instance, the exostosis between the bases of the horns is nearly one-third shorter in the present specimen than in *cavifrons*; and the depth of the former skull is much less.

In comparison with *S. tyrrelli*, which Osgood has described from the Yukon, it is very closely similar. While various differences are noted, in the absence of comprehensive information on the range of variation within the species, doubts as to exact determination are encountered; and so the specimen is referred to that form to which its close relationship is apparent.

Symbos measurements (in millimeters)

	Type of *S. cavifrons*	Type of *S. tyrrelli*	Hastings Museum specimen
Posterior border of exostosis (between horns) to fronto-nasal suture	275	241	235
Width at mastoid region	200	196	198
Width at rear of orbits	252	222	226
Width at notch between orbits and horn-cores			134
Width across occipital condyles	118	135	115
Height of skull from base of condyles to post. border of exostosis at midline	223	158	165
Height of occipital crest above base of condyles	180	125	130
Length of exostosis, on midline	267	210	193
Width of concavity of exostosis, taken at middle of base of horn-cores	125	90	72
Depth of concavity of exostosis, taken as above	36	40	32
Fore-and-aft diameter of base of horn-cores	118	100	85
Tip to tip of horn-cores, as preserved (twice right horn-core, to midline)	525	368	446
Length of horn-cores, as preserved	225	175	
Diameter of orbit	63	73	58
Length of right horn-core outside curve			235
Occipital protuberance to line joining rear of orbits		161	165
Front of foramen magnum to fronto-nasal suture, (basi-nasal line)		255	271

Cervalces Scott

In 1818, in the Proceedings of the American Philosophical Society, an account of two heads found at Big Bone Lick, Kentucky and presented to that society by Mr. Jefferson, was published by Dr. Caspar Wistar. One of these heads was assigned by Dr. Wistar to the genus *Cervus*, but the species was not named until 1825, when Harlan, in his Fauna Americana, called it *Cervus americanus*.

In 1885, Professor W. B. Scott of Princeton described a splendid and essentially complete skeleton found in a shell-marl bog at Mt. Hermon, New Jersey, which belonged to the same species as the Big Bone Lick specimen, and gave the genus the name *Cervalces*. In this report Professor Scott has given a full summary of the history and relations of the group and description of the skeleton. The race combines characters of both the deer and moose families, standing intermediate between them structually.

Following this Richard Lydekker, in his "Deer of All Lands," called attention to the fact that the specific name was preoccupied and named the species in honor of Professor Scott, *Cervalces scotti*.

In 1913 Dr. O. P. Hay described a new species under the name of *Cervalces roosevelti*, based on part of the right antler and an attached portion of the skull, including "part of the parietal, a part of the right squamosal, and the right frontal as far as the outlet of the olfactory nerve." This was found in a gravel pit near Denison, Crawford County, Iowa. The age of these beds was originally reported as Aftonian, but diverse opinions have been expressed.

Cervalces roosevelti Hay

While near Giltner, Nebraska, with Director Brooking, the writer noted parts of a skull and horns in the possession of Mrs. Mary Jackett, who had owned them some fifteen years. A little careful examination and fitting on the spot soon showed that these parts were of one individual, and that contacts between the pieces existed to make accurate restoration possible. The writer repaired and restored the back half of the skull, and the specimen adds materially to the known information of this race. The original specimen belongs to Mrs. Jackett, but the Hastings Museum has an excellent cast prepared from the original.

The discovery was made in a sand and gravel deposit a short distance from the home of Mrs. Jackett. The writer examined the spot. A local man who informed me that he witnessed this discovery stated that when men hauling gravel uncovered the specimen and removed it, it was intact and more complete than it now is. It was laid aside on the ground while the loading was being completed and a boy, who was present and had been cautioned to use care, seized a club and deliberately broke the specimen into several pieces! It was probable, my informant stated, that some of the broken parts were not picked up at that time. The specimen, fortunately, was almost flinty hard, so contacts were little damaged in the ensuing years. An examination of other fossils found at this spot includes the horses, canid, *Megatherium*, and camel listed herewith. Parts of the horns and cranium of the *Cervalces* had been irretrievably lost, but fortunately Director Brooking chanced to have some photographs taken soon after the specimen was discovered about 1912, and these supply a little additional information. Mrs. Jackett kindly loaned the specimen to the writer. It has been measured and pho-

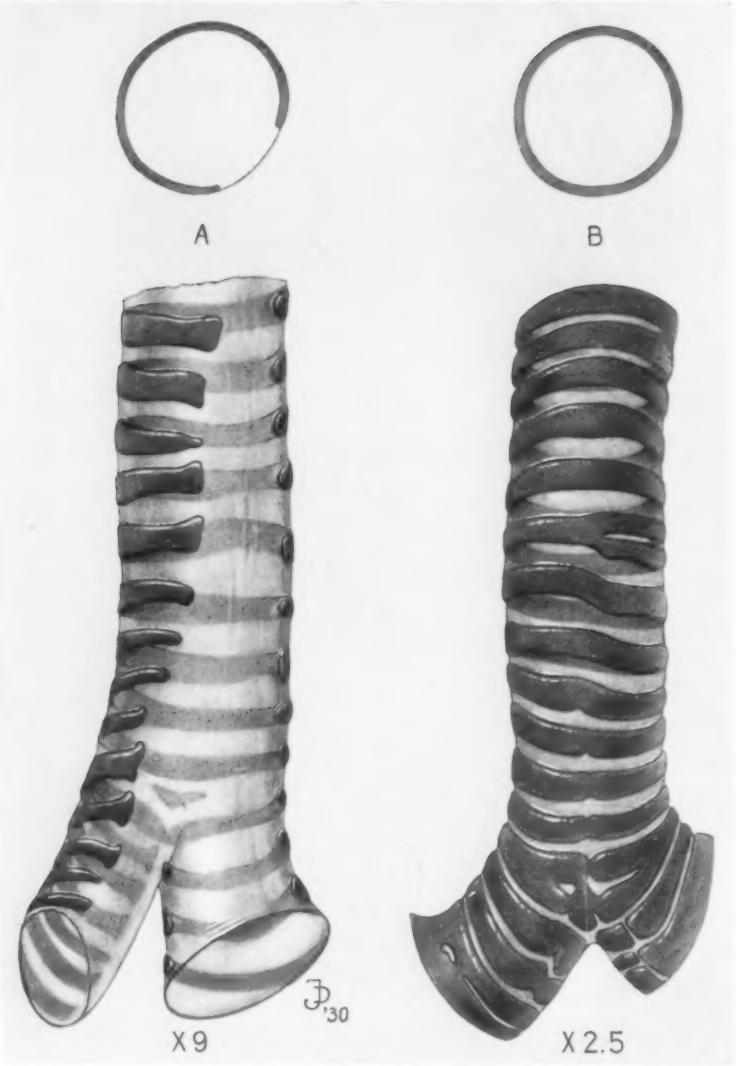
tographed and good casts taken, so that the record is preserved for science. The present specimen is somewhat larger than the type specimen but agrees with it closely in most characters, and being more complete adds light on the species. The skull is nearly complete from the orbits back, including all the brain case and basi-cranial region, occiput and condyles. Both antlers are broken off at the point where the expansion, or flange, began. The old and none too clear photographs, previously mentioned, show the horns when less damaged than at present, so add a little to our information. As in the other species of this genus, the antlers were without brow tines, running out from the skull at nearly right angles to the long axis of the skull, much as in the modern moose. This specimen has a longer shaft, before any branch or palmation occurs, than the type specimen, and the longest of any species or specimen described to date. Judging from the known antlers of *C. scotti*, this animal probably had a very large set of horns. *C. borealis* has horns somewhat shorter, being 180 mm. in length from burr to beginning of the palmation, as compared with 355 in the present specimen, and 300 in the type of *C. roosevelti*.

Measurements of C. roosevelti (in millimeters)

	Hastings Museum	Type
Greatest width of occipital condyles	102	
Height from base of condyles to crest of occiput	135	
Greatest width of brain case	122	
Distance between burrs of antlers	235	210
Diameter foramen magnum, vertical	39	
Diameter foramen magnum, traverse	40	
Circumference of antler 9 in. from infrafrontal suture	173	
Breadth of inion	174	
Length of pedicle	66	28
Breadth of forehead at post-orbital notch	212	210
Distance front of orbit to front of burr of antler	38	
Distance from line drawn at back of antlers across skull, to occiput,—taken at right angles	109	
Distance from midline of skull to burr	118	105
Diameter of beam 100 mm. from burr	55	52
Diameter of burr in plane of face	64	
Diameter of burr at right angles to this	71	
Length of antler to start of palmation (approximately)	342	300

Comparative measurements of a typical specimen of Alces, Megaceros, and Cervalces scotti, with C. roosevelti, (Hastings specimen)

	C. roosevelti	*C. scotti*	*Alces*	*Megaceros*
Length of pedicles	66	28	20	48
Distance between burrs of antlers	235	234	165	120
Breadth of forehead (post. orb. notch)	212	255	205	220



EXPLANATION OF PLATE 12

Tracheae of (A) *Galago* sp. ? ♂ (U. S. N. M. No. 251756) and (B) *Lemur variegatus* ♂ (J. H. Anat. No. 12). Above, diagrammatic view of cross-section through a tracheal cartilage, to show dorsal gap in *Galago* and completeness of the ring in *Lemur*. Below, dorsal view of lower portion of trachea and beginnings of bronchi in the cleared specimens.

THE FORM OF THE TRACHEAL CARTILAGES OF PRIMATES, WITH REMARKS ON THE SUPPOSED TAXONOMIC IMPORTANCE

By William L. Straus, Jr.

[*Plate* 12]

It is usually stated, or implied, that the tracheae of the *Lemuroidea* differ from those of the so-called higher primates or *Anthropoidea* in the completeness of the cartilaginous rings. As is well known, these cartilages do not form complete rings in man, the anthropoid apes and both groups of monkeys. Characteristically they appear as isolated hoops, incomplete on their posterior (dorsal) aspect, the free ends being united by a membrane of connective tissue which contains fibres of smooth muscle ("trachealis muscle"). In the *Lemuroidea* these rings are supposed to be complete, there thus being no dorsal gap.

I have had occasion to examine the tracheae of a number of the primates. My observations upon the *Lemuroidea* are so markedly in contrast with current notions concerning the form of the tracheal cartilages in these animals, that it seems worth while to present my findings and to correct certain misleading statements in the literature.

The tracheae of the following primates were examined: *Lemur variegatus* (J. H. Anat. No. 11); *Lemur variegatus* (J. H. Anat. No. 12); *Lemur fulvus*, fetus near term (J. H. Anat. No. C. 186); *Galago* sp. (U. S. Nat. Mus. 251756); *Nycticebus borneanus* (Wistar Inst. No. 2411); *Nycticebus* sp. (U. S. Nat. Mus. No. 142235); *Perodicticus potto* (J. H. Anat. No. 283); *Tarsius philippinensis* (U. S. Nat. Mus. No. 218238); *Tarsius saltator* (J. H. Anat. No. 169); *Callithrix jacchus* (J. H. Anat. No. 75); *Saimiri sciureus* (J. H. Anat. No. 8); *Ateles geoffroyi* (J. H. Anat. No. 150); *Pithecus rhesus* (Carnegie Embryol. Lab. "F").

I am indebted to Mr. Gerrit S. Miller, Jr., of the U. S. National Museum, Dr. Milton J. Greenman of the Wistar Institute, and Dr. Carl G. Hartman of the Carnegie Laboratory of Embryology for the loan of specimens, and to Mr. James F. Didusch for the excellent drawing of the tracheae of *Galago* and *Lemur*.

All of the animals studied, excepting of course the fetus of *Lemur fulvus*, were either adult or nearly so. At least none was a very young specimen.

Most of the preparations were dehydrated carefully and then cleared in methyl salicylate for study under the Greenough binocular micro-

scope. This procedure not only permitted examination of the trachea in greater detail, but also insured elimination of possible erroneous interpretations because of overlapping free ends of incomplete rings.

In all of the animals studied, with the exception only of the three specimens of the genus *Lemur*, the tracheal rings were found to be incomplete dorsally. The gap intervening between the free dorsal ends of the cartilages was closed by a membrane. In some few instances the ends of the cartilages overlapped dorsally. In such cases, however, it was quite apparent that here also the rings were incomplete. This overlapping is presumably a consequence of post mortem changes, an assumption strengthened by the observations of Beattie (1927) on the trachea of *Hapale jacchus* (= *Callithrix jacchus*). He stated that "in specimens which have been fixed in formol the rings overlap posteriorly, but in the fresh animal there is a distinct gap between the dorsal ends of the rings" (p. 699). Overlapping rings brought about by post mortem changes might well appear to be complete in such small animals as *Tarsius* and certain of the lemurs. The true relations in such specimens can only be determined by very careful observation or by the use of clearing methods.

I have not concerned myself with the number of rings in a single trachea. The absolute number is probably dependent upon the length of the neck. Owen (1868) states that "the chief peculiarity of the respiratory system in the Ruminant group relates to the length of the neck, with which the windpipe is made to agree by the number not the length of its rings" (p. 581). The number of rings would seem to vary even within a single genus, e. g. *Tarsius* (Burmeister 26, Woollard about 16); *Daubentonia* (Owen 26, Peters 22, Zuckerkandl 22); *Lemur* (Peters 26, Patten 32)). Nor have I concerned myself with the carina tracheae, since this does not bear upon the particular problem under consideration.

The rings are by no means of uniform character. Occasionally they are partially doubled (when complete rings), or bifid or forked (when incomplete). This partly doubled condition is figured in the accompanying plate (figure B, *Lemur variegatus*). The forked variety has been frequently reported by other workers as occurring in various animals. It is found, at least occasionally, in man. These forked cartilages were quite numerous in the tracheae of *Ateles*. I have observed that isolated bars or spicules of cartilage may intervene between the more complete rings. This condition is illustrated in the accompanying plate (figure A, *Galago*). It was quite common in the tracheae of *Ateles*. The rings may exhibit a tendency to become weaker ventrally near the caudal end of the tube; and at the end of the trachea proper and over the primary bronchi they may assume rather bizarre forms (*Lemur*, *Nycticebus*). In *Galago* (plate, figure A) the free or dorsal ends of the rings had a tendency to become slightly enlarged or spatulate. This condition was also noticeable in some of the rings of *Nycticebus*.

The tracheae of *Galago* sp. (U. S. N. M. No. 251756) and *Lemur variegatus* (J. H. Anat. No. 12) are figured (see plate) in order to illustrate the striking difference between two animals in which the tracheal rings are respectively incomplete and complete dorsally. In the *Lemur* the cartilages typically form complete hoops. Yet even this statement needs modification, for the last five or six rings of the trachea proper show a weakening in the dorsal midline. This weakening becomes

more pronounced as the bifurcation is approached. Finally, over the primary bronchi themselves, at least some of the rings become incomplete dorsally. In the fetus of *Lemur fulvus* the tracheal cartilages were essentially similar to those of the adult *Lemur*. They formed complete hoops, and there was no indication of a posterior gap. In this animal the lowest portion of the trachea and the beginnings of the bronchi were not available for study. I am therefore unable to record the fate of the rings at the end of the tube. It is interesting, and moreover most significant, that the cartilages of the *Lemur* trachea are complete rings before birth.

Recourse to some of the more recent general works that deal with the anatomy of the primates merely reveals the confusion and misconceptions which exist concerning the form of the tracheal cartilages in the *Lemuroidea*. These structures are stated as forming complete rings in the lemurs in general, and thus contrasting with the conditions in other primates. On the basis of such generalized statements, the tracheal cartilages are implied to be of taxonomic importance by at least one recent writer (Wood Jones, 1929).

Duckworth (1915) wrote that the trachea in *Lemuroidea* "is distinguished by the fact that the cartilaginous rings are complete (in Lemur), though weaker behind, where the cartilage is discontinuous in other forms" (p. 88). In *Tarsius* he noted that "the tracheal rings are complete (as in the Lemurs, excepting the Galagos)" (p. 116).

Sonntag (1924) stated that in the *Lemuroidea* "the tracheal cartilages are complete in many species, and in this respect the Lemurs differ from the higher Primates" (p. 24), and that in *Tarsius* "the tracheal rings are likewise complete" (p. 32).

More recently, Wood Jones (1929) wrote that in the lemurs "the trachea is, however, quite peculiar, inasmuch as in most forms the cartilaginous rings are quite complete behind, each being a perfect little hoop of cartilage. Even in such species as show a weakening of the posterior aspect of the rings, there is apparently no discontinuity of cartilage" (p. 103). As for *Tarsius*, he noted that "the rings of the trachea are incomplete on their dorsal aspect" (p. 154). Further on, in discussing the zoological affinities of *Tarsius*, he listed "the incompleteness of the tracheal rings" among those characters in which this animal exhibits structural affinities with the *Anthropoidea* and differs from the *Lemuroidea* (p. 172). This conclusion is quite unwarranted by observed facts, and is based entirely upon the supposed universal completeness of the rings in lemurs.

I have collected the available data bearing upon dorsal completeness or incompleteness of the tracheal rings in lemurs and *Tarsius*.

(1) The tracheal rings have been found to be *complete* in *Tarsius* sp. ? (Duckworth 1915, ? specimens; Sonntag 1924, number of specimens unknown); in *Lemur varius* = *L. variegatus* (Patten 1899, 2 (?) specimens); in *Lemur mongoz* (Duckworth 1915, number of specimens unknown); in *Lemur variegatus* (Straus, 2 specimens); in *Lemur fulvus*, fetus (Straus, 1 specimen); in *Avahis* = *Lichanotus laniger* (Milne Edwards and Grandidier 1876, number of specimens unknown); and in *Propithecus verrauxi* (Milne Edwards and Grandidier 1876, number of specimens unknown).

(2) The tracheal rings have been found to be *incomplete* dorsally in *Tarsius spectrum* = *T.* sp. ? (Burmeister 1846, number of specimens unknown; Woollard

1925, number of specimens unknown; Wood Jones 1929, number of specimens unknown); in *Tarsius philippinensis* (Straus, 1 specimen); in *Tarsius saltator* (Straus, 1 specimen); in *Chiromys* = *Daubentonia madagascariensis* (Owen 1866, 1 specimen; Peters 1866, 1 specimen; Zuckerkandl 1898, 1 specimen); in *Lemur anjuanensis* = *L. mongoz* (Peters 1852, 1 specimen); in *Microcebus myoxinus* (Peters 1852, 1 specimen); in *Otolicnus senegalensis* = *Galago senegalensis* (Peters 1852, 1 specimen); in *Galago* sp. ? (Duckworth 1915, number of specimens unknown; Straus, 1 specimen); in *Nycticebus borneanus* (Straus, 1 specimen); in *Nycticebus* sp. ? (Straus, 1 specimen); in *Perodicticus potto* (Straus, 1 specimen); and in *Indris brevicaudatus* = *I. indris* (Milne Edwards and Grandidier 1876, number of specimens unknown).

From these data it is obvious that completeness of the rings cannot be said to be characteristic of the lemurs. This condition would seem to be characteristic, in the present fragmentary state of our knowledge, only of the genera *Lemur*, *Lichanotus* and *Propithecus*. The opposite arrangement, incompleteness, apparently obtains in the genera *Daubentonia*, *Galago*, *Microcebus*, *Nycticebus*, *Perodicticus* and *Indris*, and likewise in *Tarsius*. Yet *Tarsius*, however, would seem to be rather variable in this feature, for both Duckworth and Sonntag stated that the rings may be complete. Likewise in *Lemur* the rings exhibit some variability, as witness their incompleteness in the specimen of *Lemur mongoz* studied by Peters (1852). The arrangement possesses but little group constancy. Among the *Lorisinae*, both *Nycticebus* and *Perodicticus* have incomplete rings; yet of the *Lemurinae*, *Lemur* usually has complete rings, *Microcebus* (as far as known) incomplete; while in the *Indrisinae*, both *Propithecus* and *Avahis* have the rings compete "cerceaux non interrompus"), but they are incomplete in the closely allied *Indris* (Milne Edwards and Grandidier). As far as the *Anthropoidea* are concerned, the tracheal rings are apparently always discontinuous behind; yet even in the members of this group but little is known regarding the variability of the rings in the different genera.

I am aware of no observations on the tracheal rings in any genera of the *Lemuroidea* other than those listed in the accompanying table. It is possible, indeed probable, that additional genera would exhibit complete tracheal rings. Yet even in the event of such specific evidence, it would still be unjustifiable to state that complete tracheal rings are characteristic of the *Lemuroidea*. The occurrence of incomplete rings in several genera is sufficient to prove plainly the worthlessness of such a generalization. This being so, and in view of the individual variability, the presence of a dorsal gap in the tracheal cartilages has absolutely no taxonomic value. The occurrence of such a gap no more helps to make *Tarsius* a member of the *Anthropoidea* than it does *Galago*, *Nycticebus* or other animals indisputedly assigned to the *Lemuroidea*.

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AGE CLASSES OF WHITETAIL BUCKS KILLED IN NORTHERN MICHIGAN IN 1929[1]

BY VICTOR H. CAHALANE

During the deer hunting season of 1929, the Michigan Department of Conservation took measurements of a number of antlers of whitetail deer (*Odocoileus virginianus borealis*) from the Upper Peninsula. The objective was a determination of the relative numbers of deer by age classes.

Such a determination is badly needed in game management. On the relative numbers of animals in various age classes should depend the number to be removed by hunting—the much-discussed "annual increase." This rate of annual increase is impossible to judge by field observations, and the fluctuation of the rate from year to year is a matter of the highest importance to the stocking of the species. In any hunted deer country, allegations based on observations are almost constantly

[1]This paper is based on work done while the writer was employed by the Game Division, Michigan State Department of Conservation.

being made concerning the relative number of deer, as compared with that of years gone by, and concerning the shrinkage or increase in the fawn crop.

With a method available by means of which the number of deer in any one age class, in terms of percentage of the total kill, may be derived, a dependable figure may be obtained. With an appreciable proportion of the total yearly kill subjected to mathematical analysis which resolves it into the fundamental age classes, the study only needs continuance each hunting season to supply a fairly accurate check on the fawn crop. An appreciable drop in the birth rate, or a disease whose mounting fatalities are not directly noticeable in large numbers of carcasses, should reflect its results in a lowered ratio of the number of deer killed in the youngest age class in proportion to the total kill. Beneficial conditions should result in a proportional increase of young animals. This upward or downward trend should be appreciable as soon as the affected age class reaches the legal limit. In states where there are no restrictions and where fawns may be legally hunted, the proportion of fawns to adults, as represented in the kill, may be obtained by simply tallying the two. In states such as Michigan, where fawns are protected by law, more indirect means must be used to arrive at the proportion between the youngest age-class and the total kill. As will be explained below, measurement of the diameter of the antlers is necessary.

METHOD

A report, now in press, will shortly be made on a method for determining the age of male whitetail deer. This method is based on the theory, worked out after a study of a series of approximately 260 skulls, that (1) the diameter of the antler beam about one-half inch above the burr increases in each successive set of antlers, and that (2) the beam-diameters of Michigan whitetail deer of any one age are so restricted in range that this measurement may be used, within certain limits, to differentiate and identify various age classes of deer. On this basis, male deer are separated into the essential age-classes by the measurements given in table 1.

Michigan is particularly fortunate, for the facile gathering of data on deer, in the distribution of her forest areas. The Upper Peninsula, completely isolated from lower Michigan by the Great Lakes, has for some years afforded the greater amount of purely wilderness deer hunting, and the yearly kill is probably larger than that in the Lower Peninsula. The State Highway Department ferries across the Straits of

Mackinac transport a very large percentage of all Upper Peninsula deer killed by hunters who reside in lower Michigan, Ohio, Indiana and Illinois. Thus the vast majority of the deer taken out of this part of the state pass through St. Ignace, the northern terminus of the ferries, as into the neck of the giant funnel represented by the entire Upper Peninsula.

A policing post for the purpose of checking on illegal game is usually established on the ferry dock, and this, plus delays occasioned by waiting for transportation, gives an excellent opportunity to make the necessary measurements of the antlers of deer on automobiles and trailers of hunters returning to their homes.

Three measurements were taken, as follows:

(1) Average diameter in millimeters of the antler beam. Because of the roughened condition near the base of many antlers, particularly of

TABLE 1

Age classes of deer by antler diameter classes

DIAMETER OF ANTLER BEAM	AGE
mm.	*years*
Up to 19	1½
20–22	Divide equally between 1½ and 2½
23–27	2½
28–34	3½–4½
35–37	One-third are 3½–4½ Two-thirds are 5½
38 +	5½ +

the older deer, the measurement was not made at an exactly uniform distance above the head, but was taken *about* one-half inch above the top of the burr.

(2) Average diameter of the burr in millimeters, obtained, as was (1), by averaging greatest and least diameters.

(3) Number of tines per antler, per head. All projections extending 2 cm. or more from the beam were counted.

The work was done by a two-man crew, under the direction of M. C. Wakeman, of the Department's Game Division.

Because of the following factors the total kill of deer for the Upper Peninsula is unknown: (a) no reports of the kill are required by the state game law; (b) some of the carcasses leave the territory via the Wisconsin border, and from these no data were obtained; (c) a con-

siderable but unknown percentage of the kill is made by Upper Peninsula residents, and on this reliable data are difficult to gather. However, out of a total of approximately 6300 deer shipped across the Straits on the state ferries during the hunting season, 1892, or about 30 percent, were measured for this age study. This seems to be an adequate number on which to base general statements regarding the deer herd of the area involved.

The graphs are largely self-explanatory. One gives tines per head and per left and right antler. This shows that the heaviest killing was made in the "eight-point" class, while only about 10 percent (182 out of 1892) killed were spike-horn bucks. The 21-point head was still partially in the velvet and was undoubtedly one of the near-freaks not uncommon among deer.

TABLE 2

Number of deer by age classes

AGE CLASS	NUMBER OF DEER	PERCENT OF TOTAL
years		
1½	547	29
2½	453	23
3½–4½	612	32
5½	316	16

The second graph shows the relationship between burr- and beam-diameters for each antler by number of deer. It will be seen that the former tends to be less regular than the diameter of the beam. The latter, as explained previously, is the factor found to correlate most closely with age, and applying the previously given formula for determination of age, the animals tallied may be classified as shown in table 2.

The youngest age-class, of course, is the one to be watched from year to year as similar studies of the deer kill are made. Radical fluctuation below its numerical status in "percent of total" will presumably mean that the young deer, as a percentage of the total population, have decreased, and that the cause should be sought out immediately with a view to restoring a more nearly normal rate of birth and survival.

ESTIMATE OF AGE CLASSES

From the above table, also, may be derived a rough preliminary estimate of the proportions or ratios between the age classes of the male deer population of the Upper Peninsula. In considering the percent-

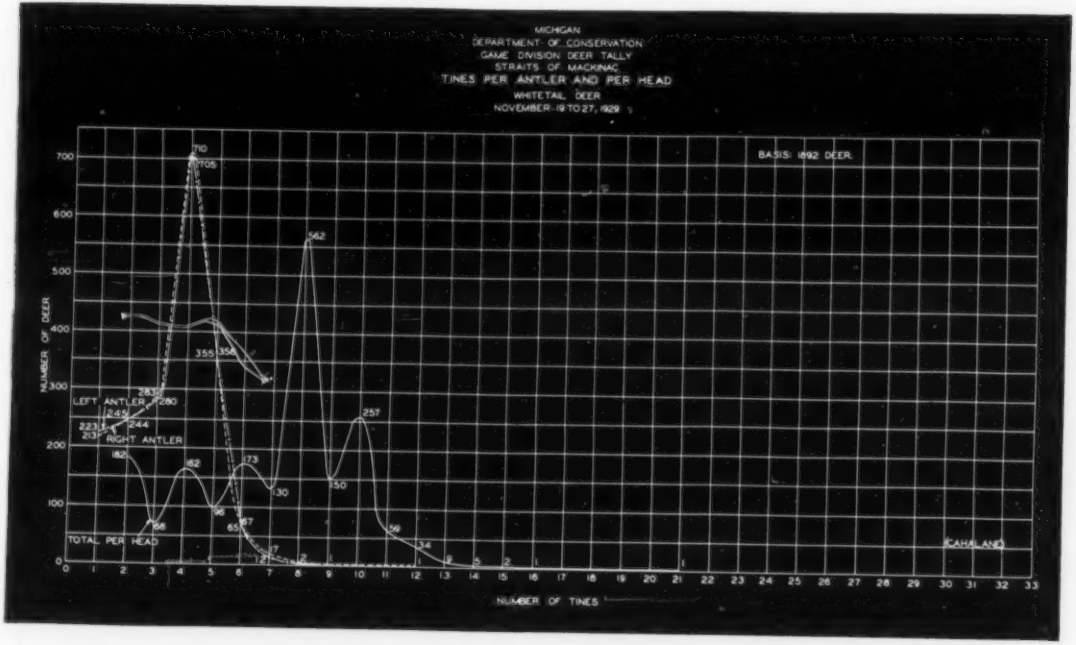

FIG. 1. FREQUENCY CURVES SHOWING NUMBER OF TINES FOR RIGHT AND LEFT ANTLERS AND TOTAL NUMBER OF TINES FOR EACH HEAD

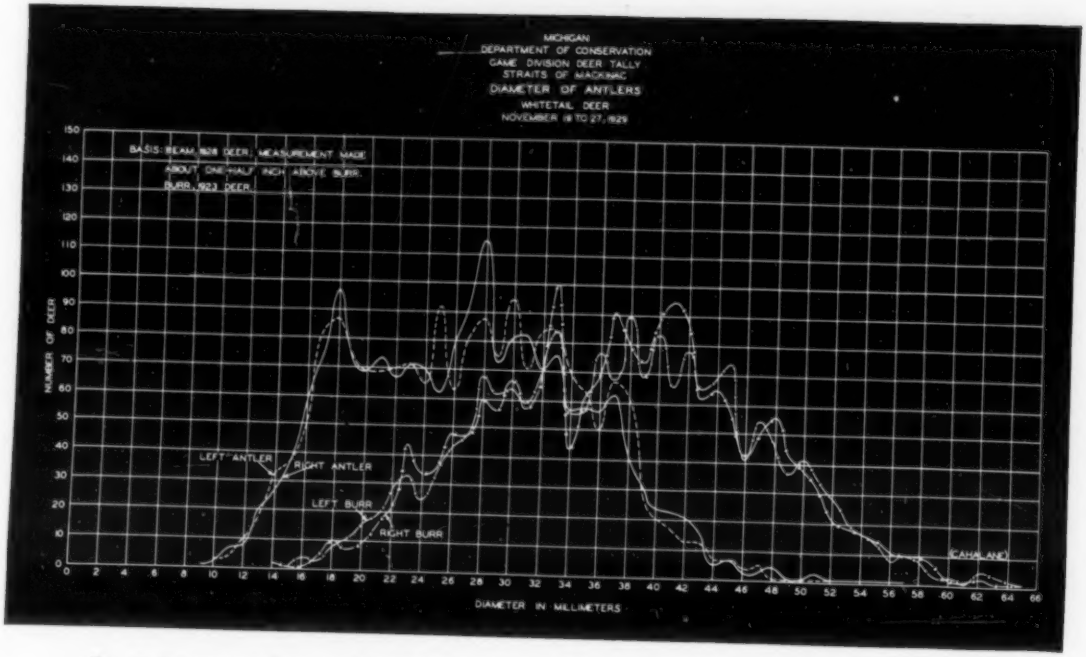

FIG. 2. FREQUENCY CURVES SHOWING DIAMETERS OF RIGHT AND LEFT ANTLERS AND OF THE BURRS.

ages (above) it must be noted that fawns, or deer in the one-half year age-class, were not hunted and therefore did not enter the tally at the Straits.

The best available figure for the ratio between adult (antlered) males and fawns is that resulting from a tally of live deer made by field officers in the region during the summer and fall of 1929. About one hundred officers and refuge keepers reported all deer actually seen by them during the period from July to December, inclusive, divided into bucks, does and fawns. Strict instructions were given to classify as "uncertain" every deer not positively identified as being in one of the above three sex-age classes. This tally gives a grand total of 1905 fawns to 982 bucks reported, or about twice as many fawns as bucks. Assuming that half the fawns are females and half males, the *total male* population is therefore about 50 percent adults and 50 percent animals in their

TABLE 3

Estimated percentage of total male Michigan deer population, by age classes

AGE CLASS	PERCENT OF TOTAL MALES
years	
½ (fawns)	50
1½ (yearlings)	15
2½	11
3½–4½	16
5½ and older	8

first year. Each of the age-classes of adult (male) deer given above should therefore be reduced by 50 percent in order to include the fawn population in a statement of the total population.

The male deer population has for nearly ten years been placed under toll during the annual hunting season, while the does have been, legally at least, exempt. It would be going unreasonably far, therefore, to attempt to estimate from the figures on the kill of males the percentage of age-classes of the total deer population. The preceding estimate for males, because based on only one season's figures, is only tentative, but in the course of a few years, with tallies of antler-diameters being made each season, the element of chance will be reduced and a fairly reliable estimate can be made of the proportion of age classes in the adult male deer population. Similar figures for the females must wait until the data can be collected and a method for age determination worked out for that sex.

EXPERIMENTS IN RE-ESTABLISHMENT OF MUSK-OXEN IN ALASKA

By W. B. Bell

No authentic records seem to be available of the existence of musk-oxen in Alaska since its exploration by Europeans. Statements made by natives indicate that the animals had practically disappeared from the Territory about 100 years ago. Rumors have it that a few scattered bands have been found and killed there since, but we may consider that Alaska's musk-oxen had already joined the European and Asiatic forms that had disappeared from the face of the earth, leaving only skeletal remains to prove the original wide range of this group.

Musk-oxen have since persisted in parts of northern Canada, the Arctic islands, and in Greenland, but their numbers gradually have dwindled to a point where there is reason for genuine concern over the possible extinction of this remarkable species of northern animal. In this critical situation the Canadian government has acted with characteristic vigor and promptness to afford protection to the remaining herds within its territory. One of its most notable efforts has been the establishment of the Thelon Sanctuary, an area of 15,000 square miles, along the Thelon River, east of Great Slave Lake, where about 250 animals still range, and where conditions are particularly favorable to afford them complete protection.

For several years there has been much interest in an effort on the part of officials and individuals interested in mammal conservation work to re-establish musk-oxen in the range formerly occupied by them in Alaska. The Legislature of the Territory of Alaska, in April of 1927, addressed a memorial to the Senate and House of Representatives of the United States, urging favorable action in appropriating funds for this purpose. An appropriation of $40,000 was granted by Congress during May of 1930, under the active leadership of Senator Peter Norbeck of South Dakota, and Representative C. C. Dickinson of Iowa. The measure was approved by the President on May 27, 1930.

As soon as funds were assured the Biological Survey of the United States Department of Agriculture obtained telegraphic bids from persons from whom musk-oxen might be purchased. As it was impracticable to obtain representatives of any of the races that originally occurred in continental North America, it was necessary to buy animals of the subspecies *Ovibos moschatus wardi* Lydekker, which occurs in northeast Greenland. These differ only in minor characters from those

formerly native to Alaska. An order was placed by cable with Mr. Johs. Lund, of Aalesund, Norway, who has had extended experience in capturing these animals in Greenland. In the latter part of August the Biological Survey was advised that 34 animals had been captured—including 19 females and 15 males—about half the number being calves of the year and the remainder ranging up to about two years of age.

The leader of the expedition gives the following information regarding the animals, and the procedure followed in their capture:

> The animals nearly always appear in flocks but are only seldom met. The older ones range by themselves while the young ones keep together. They are generally guided by a leader. There is much violence in a flock of musk-oxen. Once we saw a flock of 18 grazing in a plain. Two of the animals wandered away from each other to a distance of some 50 metres, then took a run and flew against each other. The loser left the battlefield. The animals pasture like cows. Sometimes they will set out at high speed for a distance of 100 to 1,000 metres when they stop short. When attacked they draw up into a flock with the leader at the head and then make a sally unflinchingly. The animals are swift, and keen of scent, so extreme care must be taken in undertaking to capture them and such hunting is as much as one's life is worth. When the older animals have been disposed of the young are captured alive by use of a lasso made of particularly strong rope. The legs of the young animals are bound together and they are carried aside. The whole affair is a matter of seconds and you must be quick, for the remaining animals might attack you, and even the young ones are not to be trifled with. It is no easy thing to transfer the animals to the vessel. There is likely to be some trouble. The year-old calves are easily caught and managed. It is a great advantage that they have no horns. About two or three men are able to manage such a calf with their bare hands. By means of a muzzle or halter we contrived to get them on board the boat. Many are rather refractory but we leave them as much as possible to themselves during the transporting. Then we get them into the whaling boat and upon reaching the ship's side we heave the whole boat on deck with the animals in it. We then put them in spacious and solid cases made of two-inch boards. At first the animals try their strength against the sides of the cases, but when after a while they understand that the cases are stronger than themselves they give in. After a day or two they begin to feed. First they take some water and then they want some grass plucked on the spot. It is no use to give them hay or grass grown in contaminated fields as the animals fall ill with such grass and hay, and die. They are very particular although hardy; for instance, they never taste water that is not entirely fresh. They soon get used to man. Having been in the crates on deck for about a week they easily understand that there will be a dainty tidbit when members of the crew approach with grass or moss. The young ones are the most easily naturalized. Therefore, we catch young animals by preference.

Carried thus in crates and fed on native hay obtained in Greenland, the musk-oxen were transported to Norway, where they were shipped

from Bergen on September 6, 1930, on the Norwegian-American Line steamship *Bergensfjord*. A few days later, September 15, 1930, the animals were landed at the port of New York. All the details covering permits for their entry into the United States had been successfully cared for. These included delicate diplomatic negotiations, which it was necessary to route through the State Department in order not to disturb long-standing treaty agreements and other arrangements between the governments concerned.

In order to insure against the introduction of foot-and-mouth disease, rinderpest, surra, or other diseases of ruminants, it was necessary under Department regulations to hold the animals in quarantine for 33 days at the Bureau of Animal Industry Quarantine Station at Athenia, New Jersey. They were received at the port by L. J. Palmer, in charge of the Biological Survey experiment station at College, Alaska, and E. A. Preble, of the Washington office of the Biological Survey, who had experience with musk-oxen in carrying on his natural history work in Canada. Dr. James Fleming, in charge of the quarantine station, took an active interest in the care of the animals from the first, and it is a fine tribute to him and his assistants, and to Mr. Palmer and his assistant, Charles H. Rouse, that they came through the long quarantine period in excellent health, with no trace of disease or special disturbances of normal functioning. To avoid possible introduction of disease-producing organisms, it was required that no hay on which the animals had been accustomed to feed should be brought with them to this country. It was necessary to transfer them at once to a diet of American-grown alfalfa hay. With a bit of coaxing and skillful handling by Mr. Palmer and Mr. Rouse, the animals took quite readily to the new food. They were fed and watered three times daily, taking their water from shallow pans. Blocks of salt were placed in each crate, and a considerable quantity was eaten. During the warm weather prevailing at the time, they drank much water and showed some signs of distress, breathing heavily and feeding less than usual. Clearly they preferred the cooler days. Approximately one-fourth of the alfalfa hay, fed them at a daily rate of 7½ pounds per animal, was wasted, so that the actual weight consumed was about five pounds each.

In order to avoid complications the animals were kept in their roomy comfortable crates throughout the entire period of the shipment and quarantine. When in repose they were rather bland in appearance, having the mild, kindly expression of the domestic bovine. When startled or in a pugnacious mood, however, the eyes showed fire, they emitted a

startling snort, and with a quick spring forward would butt the sides of the crates with the utmost vigor, causing the crates to advance by inches with each resounding thump. When hungry they bawled somewhat like young calves. It was my good fortune to make final inspection, to oversee arrangements for transfer of the animals from the quarantine station to the two 72-foot steel express cars, and to accompany them as far as Jersey City, N. J. The individual crates were hauled on an ordinary stoneboat from the barn to the cars, where each was pushed aboard and shoved into the space allotted. Alfalfa hay was loaded in each car, and an abundance of water was supplied in barrels. Mr. Palmer and Mr. Rouse made up their bunks in the cars along with the animals, in order that they might at all times give the closest possible attention to their needs.

The railroad and express company officials took an active interest in the shipment, and all along the route of travel people wanted to get a look at the animals. The journey from New York to Seattle was uneventful and required between four and five days. At Seattle they were transferred to the steamship *Yukon* of the Alaska Steamship Line, for the seven-day journey to Seward, Alaska. There they were loaded on four ordinary box cars and transported over the Alaska Railroad to the experiment station of the Biological Survey at College, Alaska, a journey of four days by slow freight. They arrived at College on the night of November 4, and were unloaded the following morning, November 5, 1930.

When the shipment left Jersey City, the temperature in the cars was about 60 degrees. Cooler weather was soon encountered, and the average temperature in the cars ranged usually between 40 and 50 degrees Fahrenheit, the lowest being 33 degrees. At Seattle the temperature rose to 60 degrees. The first two days on shipboard the temperature went up to 72 degrees. By keeping the hatch wide open the temperature was lowered, and for the remainder of the trip it ranged between 50 and 60 degrees. At Seward snow and freezing weather were encountered. During the trip to College the temperature in the box cars fluctuated between 20 and 40 degrees. At the experiment station when the musk-oxen were released the temperature was at 16 degrees above zero.

The animals were released in a 40-acre enclosure on the college campus, where they have been held temporarily for careful observation, handling, and feeding experiments, preparatory to releasing them in the large fenced enclosure on the 7,559-acre pasture included in the experi-

ment-station area. All the animals reached their destination fat and in excellent condition. Each was weighed before release and a record made as a basis for later calculations of growth. The yearling musk-oxen averaged 205 pounds; the smallest weighed 175 pounds, and the largest, a cow probably two and one-half years old, 284 pounds. The calves averaged 104 pounds, the smallest 74, and the largest 131. All were ear-tagged for purposes of identification.

Upon release most of the animals appeared dazed as if uncertain what was going to happen next. Many of them were reluctant to leave the crates and had to be forced out. With one exception they wandered slowly about the corral, where they were very docile, but had a few fights of brief duration. The one exception was one of the larger animals that, immediately upon release from his crate, started at a dead run and kept going for about one-quarter of a mile, butting into the pasture fence several times along the way. He later calmed down and joined the main herd. As there was snow on the ground many of the animals immediately started to eat it. The young animals soon discovered the feed racks in the pasture and took the lead in eating. Most of the larger ones, ignoring the feed racks, sauntered out into the pasture and began to feed on dry grass and on twigs of shrubs, such as Alaska tea. The larger animals remained away from the feed racks about two days, but the little fellows, having discovered what they were for, had been making good use of the feed. Soon the entire herd assembled at the racks and wandered away very little.

On the whole the animals proved quite tame and were easily approached and driven. The smaller ones were the most tractable, and two or three promptly yielded to petting and handling. In feeding, the animals showed little evidence of being disturbed, and the attendants wandered among them with impunity.

Since arrival at the station the musk-oxen have made satisfactory gains in weight. On March 23, eight male calves showed an average weight of 138 pounds and 9 female calves, 135.8 pounds. The average of all calves was 136.8, an average gain of 32.8 pounds since arrival at the station. Eight male yearlings averaged 241.2 pounds and 9 female yearlings, 226.8; the average of all yearlings was 233.5, an average gain of 28.5 pounds.

The only serious trouble experienced in feeding has come from an attempt to place the animals on a college-dormitory ration. During the fore part of January an attempt was made to feed them potato peelings from the college kitchen. The animals ate these readily for about

4 days, when splotches of blood were noted on the feed racks. Investigation showed that several of the animals had cuts on the lips. In tracing the cause, it was discovered that the potato peelings had become frozen before all could be eaten, and apparently the animals were cutting themselves on the sharp frozen edges. Outdoor feeding of these peelings was promptly discontinued.

A day or two thereafter warty growths were noticed on the noses and lips of several of the animals. These apparently were due to an infection similar to that causing lip-and-leg ulceration in domestic sheep. The infection normally gains entrance to the tissues through wounds, cuts, or abrasions of the skin, and sets up areas of inflammation and necrosis. In the case of the musk-oxen the infection occurred only about the mouth and nose, there being no indication of trouble about the hoof. The disease developed rapidly almost over night and the entire herd was affected, the calves most seriously, the yearlings less so. The animals were treated, and now with one exception the infection seems to have reached a dormant stage and in many instances has disappeared entirely. In addition to this malady two animals have suffered injuries which led to infection and resulted in their death.

Despite these occurrences, however, the effort to make a plant of musk-oxen in Alaska seems to be off to a good start.

U. S. Biological Survey.

THREE NEW CHIPMUNKS OF THE GENUS EUTAMIAS FROM NEVADA

By William Henry Burt

A collection of mammals taken in southern Nevada, chiefly during the summers of 1928 and 1929, has revealed three apparently undescribed races of chipmunks from the mountains of that region. Pending the completion of a detailed report on the material from this section, it seems advisable at this time to make these three races known to other workers in the field. They are therefore described as follows:

Eutamias panamintinus juniperus, subsp. nov.

JUNIPER CHIPMUNK

Type.—Male adult, skull and skin; no. 15,712, collection of Donald R. Dickey; one-half mile west of Wheeler Well, west slope Charleston Mountains, Clark County, Nevada; altitude 6700 feet; June 19, 1929; collected by W. H. Burt; original no. 2205.

Subspecific characters.—Resembles *Eutamias panamintinus panamintinus* (Merriam) in size, but differs from that form in coloration as described below. Color of fresh summer pelage of type: top of head "smoke gray"[1] faintly mixed with "pinkish cinnamon;" median dorsal stripe, extending from between ears to rump, "mikado brown" mixed for much of its length with "fuscous-black;" lateral dark stripes similar to median, but with less of the "fuscous-black;" central light dorsal stripes white, faintly suffused with "mikado brown;" lateral stripes white; rump "smoke gray;" post-auricular patch white, extending up posterior one-third of ear; anterior portion of ear "mikado brown;" ocular streak blackish, suffused with "mikado brown" in front of ear; submalar stripe indistinct, "warm sepia" (in some specimens near "mikado brown"); sides of body "mikado brown" shading to "sayal brown" ventrally; feet grayish, very faintly washed with "pinkish buff"; dorsal surface of tail "fuscous-black" overlaid with "pinkish buff," the proximal portion of hairs "chaetura-black," followed by an intermediate zone of "clay color;" ventral surface of body white. Skull similar to that of *panamintinus*.

There is very litt'e variation in the series at hand, all specimens in new pelage agreeing closely in every essential with the type. The worn winter pelage is much paler and duller in every respect than the new pelage described above.

Comparisons.—The form here described needs to be compared only with *panamintinus* from which it differs in the following respects: more grayish head and rump, the rump not being washed with yellowish as in *panamintinus;* paler and less yellowish coloration of feet; duller, darker coloration of brownish areas.

Measurements of type.—Total length, 205 mm.; tail vertebrae, 86; hind foot, 32; ear from crown, 14. Skull: greatest length, 34.2; zygomatic breadth, 18.5; cranial breadth, 15.8 ; interorbital constriction, 7.2; length of nasals, 10.3.

[1] Color terms in quotations from Ridgway, Color Standards and Color Nomenclature, 1912.

Distribution.—Known only from the piñon-juniper belt of the Charleston Mountains, Clark County, Nevada, at altitudes ranging from 6000 to 6700 feet.

Remarks.—*Eutamias panamintinus juniperus* is not a strongly differentiated race, but in mass effect the available series differs from a comparable series of five specimens of *panamintinus* from the Panamint Mountains, California, in having the grayish areas distinctly paler and the brownish areas darker and duller.

Specimens examined.—*Eutamias panamintinus juniperus:* 18 skins and 9 skulls, all from the Charleston Mountains, Nevada; *Eutamias panamintinus panamintinus:* 20 skins with skulls from the Panamint Mountains, California (Museum of Vertebrate Zoology collection); one skin with skull each from the White Mountains, California and Casa Diablo, Mono County, California (Dickey collection).

Eutamias quadrivittatus nevadensis, subsp. nov.

SOUTHERN NEVADA CHIPMUNK

Type.—Male adult, skull and skin; no. 15,884, collection of Donald R. Dickey; Hidden Forest, Sheep Mountains, Clark County, Nevada; altitude 8500 feet; July 13, 1929; collected by W. H. Burt; original no. 2337.

Subspecific characters.—A chipmunk of the *quadrivittatus* group (see A. H. Howell, Revision of the American Chipmunks, North American Fauna, no. 52, pp. 29–30, 79–105). Resembles *Eutamias quadrivittatus inyoensis* Merriam, but much paler and grayer throughout, the tawny areas being restricted, and the gray areas clearer and less suffused. The dark facial markings are narrower and less distinct; the ventral surface of the tail is distinctly paler; and the feet lighter, clearer gray. General coloration of upperparts grayish; median dorsal stripe, extending from crown between ears to rump, black faintly bordered with "verona brown;" lateral dark dorsal stripes similar to median stripe, but with anterior one-third deeply suffused with "verona brown;" central light dorsal stripes grayish, slightly lighter than head and rump; lateral stripes white; head and rump "pale smoke gray;" post-auricular patch grayish white, a narrow margin extending up posterior border of ear; anterior portion of ear "fuscous-black" mixed with "verona brown" at base and bordered by light gray; ocular stripe black grading into "verona brown" in front of ear; submalar stripe nearly obsolete, "sayal brown;" sides of body grayish washed with "verona brown;" feet grayish very faintly washed with "pinkish buff;" dorsal surface of tail black overlaid with "tilleul buff;" ventral surface of tail "cinnamon buff" narrowly bordered by black then by "tilleul buff;" ventral surface of body white. Skull similar to that of *inyoensis* in size, but differing in having the nasals extending further posteriorly with respect to the premaxillae. In a series of 19 specimens of *inyoensis* from the White Mountains, Mono County, California, the nasals extend posterior to the premaxillae in one specimen, terminate even with them in five specimens, and anterior to their posterior termination in 13 specimens; whereas, in a series of 25 *nevadensis* the nasals extend posterior to the premaxillae in 11 specimens, terminate even with them in 12 specimens, and anterior to their posterior termination in two specimens.

Eutamias quadrivittatus nevadensis differs from *Eutamias adsitus* Allen in narrower dark dorsal stripes and facial markings, and in paler coloration of head,

rump, sides, feet, and ventral surface of tail. Differs from *Eutamias palmeri* Merriam in the much darker dorsal stripes, black instead of brownish anterior portion of ears, and paler coloration of ventral surface of tail.

Measurements of type.—Total length, 205 mm.; tail vertebrae, 89; hind foot, 32; ear from crown, 13. Skull: greatest length, 34.8; zygomatic breadth, 19.3; cranial breadth, 16.2; interorbital constriction, 7.4; length of nasals, 11.0.

Distribution.—Known only from the Sheep Mountains, Clark County, Nevada, where it occurs commonly in yellow pine, fir, and bristle-cone pine associations at an altitude of 8500 feet and possibly higher.

Remarks.—The subspecies *nevadensis* is apparently restricted to the Sheep Mountains where it is cut off from other mountain ranges by extensive stretches of desert. It is clearly, according to external characters, of the *quadrivittatus* group as given by Howell (*Ibid.*), but is an extremely pallid form.

Specimens examined.—*Eutamias quadrivittatus nevadensis:* 32 skins with skulls, all from the Sheep Mountains, Nevada; *Eutamias adsitus:* 7 skins with skulls, all from Utah (Museum of Vertebrate Zoology collection); *Eutamias quadrivittatus inyoensis*: 21 skins with skulls, all from the White Mountains, California (Dickey collection); *Eutamias palmeri*: 63 skins and 55 skulls, all from the Charleston Mountains, Nevada (Dickey collection).

Eutamias dorsalis grinnelli,[2] subsp. nov.

PALLID CLIFF CHIPMUNK

Type.—Male adult, skull and skin; no. 15,979, collection of Donald R. Dickey; Mormon Well, Sheep Mountains, Clark County, Nevada; altitude 6500 feet; July 22, 1929; collected by W. H. Burt; original no. 2368.

Subspecific characters.—Resembles *Eutamias dorsalis dorsalis* (Baird) in size, but distinctly paler in general coloration. Coloration of upperparts grizzled gray; narrow median dorsal stripe, extending from the neck to the rump, "fuscous-black" intermingled with "burnt sienna;" lateral light dorsal stripes showing very faintly in some specimens; head slightly darker than back; post-auricular patch whitish, extending up along the posterior half of ear; anterior half of ear near "cinnamon;" sides of body and dorsal surfaces of hind feet "pinkish cinnamon;" dorsal surfaces of front feet also "pinkish cinnamon," but slightly paler; facial markings narrow and indistinct; ventral surface of body white; ventral surface of tail "ochraceous-tawny" bordered by a narrow strip of black, then a wider margin of "tilleul buff;" dorsal surface of tail black overlaid with "tilleul buff." Skull similar to that of *dorsalis*.

Comparisons.—Differs from *dorsalis* in much more pallid coloration of upperparts, in paler coloration of ears, narrower and paler facial markings, and in paler coloration of ventral surface of tail. Differs from *Eutamias dorsalis utahensis* Merriam, in comparable pelage, as determined by examination of a topotypical series from the U. S. Biological Survey collection, in much more pallid, more grayish coloration of upperparts with less tawny admixture, and in narrower and

[2] Named for Dr. Joseph Grinnell in recognition of his contributions to the knowledge of California and Nevada mammals and in appreciation of his stimulating influence during my recent studies under his direction.

less distinct facial markings, paler colored ears and feet, and, in most specimens, more obscure lateral stripes.

Measurements of type.—Total length, 212 mm.; tail vertebrae, 94; hind foot, 31; ear from crown, 15. Skull: greatest length, 35.4; zygomatic breadth, 19.8; cranial breadth, 17.2; interorbital constriction, 7.8; length of nasals, 10.6.

Distribution.—As far as known this form occurs only in the Sheep Mountains and in the low adjoining Las Vegas Range in southern Nevada where it is to be found commonly in the piñon pine, juniper, and yellow pine associations at altitudes ranging from 6500 to 8500 feet.

Remarks.—The Sheep Mountains and Las Vegas Range to which the race *grinnelli* is apparently limited in distribution are in reality one mountain mass. Mormon Well is located in the head of the valley which separates the two. This chipmunk is not known to occur to the westward in southern Nevada. To the east, at Cedar Basin in the low mountains thirty miles by road southeast of St. Thomas, Nevada, it is replaced by *utahensis*. I am unable to differentiate a series of specimens from the latter locality from topotypes of *utahensis* from Ogden, Utah. In spite of the lack of any intergradation in characters, or of any intervening terrain suitable as a habitat for the group, they are nevertheless here considered as races of the same species, rather than as distinct species, because of their general similarity in body marking and also because of the possibility that the future will demonstrate intergradation in the broken country to the north. The extreme difference in the habits of the two races is interesting, *utahensis* as we observed it at Cedar Basin being strikingly wilder than *grinnelli* in the Sheep Mountains.

Specimens examined.—*Eutamias dorsalis grinnelli:* Sheep Mountains, Clark County Nevada, 41; *Eutamias dorsalis dorsalis:* Arizona, 12 (Museum of Vertebrate Zoology collection, 11; Dickey collection, 1); *Eutamias dorsalis utahensis:* Nevada: Cedar Basin, 6 (Dickey collection); Manhattan, 2. Utah, 10 (Biological Survey collection).

I wish to thank those in charge of the collections of the Museum of Vertebrate Zoology, University of California at Berkeley, and of the U. S. Biological Survey for the loan of pertinent material used in the preparation of this paper.

California Institute of Technology.

NEW CARNIVORES AND RODENTS FROM MEXICO

By E. W. Nelson and E. A. Goldman

Recent studies of the extensive collections made by the writers in Mexico many years ago have resulted in the discovery of several new races of mammals which are here described.

Vulpes macrotis tenuirostris, subsp. nov.

Trinidad Valley Desert Fox

Type.—From Trinidad Valley, northwest base of San Pedro Martir Mountains, Lower California, Mexico (altitude 2,600 feet). No. 140394, male adult, skin and skull, U. S. National Museum (Biological Survey collection), collected by Nelson and Goldman, July 1, 1905. Original number 17371.

Distribution.—Known only from the open desert in Trinidad Valley, on the Pacific slope in the mountains of northern Lower California.

General characters.—A subspecies of medium size, with skull characterized by very slender rostrum combined with a large, fully inflated braincase. Closely allied to *Vulpes macrotis macrotis*, but skull differing in more depressed frontal outline and in other details. Similar to *V. m. arsipus*, but color somewhat darker, the outer sides of limbs more ochraceous tawny, and cranial characters distinctive. Differing from *V. m. devius* in larger general size and in form of skull.

Measurements.—Type: Total length, 835 mm.; tail vertebrae, 320; hind foot, 132. An adult male topotype: 780; 295; 132. Average of four adult female topotypes: 745 (735–765); 268 (249–280); 125 (122–128). *Skull* (type): Greatest length, 114; condylobasal length, 110.2; breadth of braincase, 44.6; zygomatic breadth, 60.8; least width of rostrum, 15; interorbital breadth, 21.8; maxillary toothrow (front of canine to back of last molar), 53.3; upper carnassial, crown length of outer side, 10.2, crown width anteriorly, 5.

Color.—Type (in much worn summer pelage): Top of head ochraceous buff, thinly overlaid with white; upper parts in general faded and worn, the general tone over dorsum buffy brownish, the rump retaining rather dark, grizzled remnants of the winter coat; sides of body light buff; lips and chin dusky, throat white; rest of under parts, sides of neck, and inner sides of limbs near light ochraceous buff, becoming near light buff on inguinal region; outer sides of limbs rich ochraceous tawny; sides of muzzle dusky; outer sides of ears buffy brownish, inner sides thinly clothed with white hairs; feet dull whitish; tail grayish above, becoming buffy below near base and brownish black at tip all around.

Skull.—Similar in size to that of *V. m. macrotis*, but frontal region more depressed, so that frontal profile forms a more nearly straight, descending line from the apex well back between the parietals; braincase broader, more inflated laterally; zygomata more widely spreading posteriorly, auditory bullae averaging slightly larger and more inflated; rostrum very slender, with toothrows long and dentition about as in *macrotis*. Compared with *V. m. arsipus:* Skull similar in size and slope of frontal profile, but braincase broader and more inflated laterally; rostrum usually more slender; auditory bullae averaging slightly larger; toothrow

usually longer, but dentition similar. The skull differs from that of *V. m. devius* in larger size, much broader braincase, and actually as well as relatively more slender rostrum.

Remarks.—*V. m. tenuirostris* is known only from Trinidad Valley but probably occurs in other valleys along the Pacific slope of the mountains of northern Lower California. It is closely allied to *V. m. macrotis* and *V. m. arsipus*, but the characters pointed out are distinctive. The darker color of the legs in this form as contrasted with *arsipus* is associated with the greater humidity of its habitat, in comparison with the extreme aridity of the range of the latter. The only specimens available are in very much worn summer pelage, and the color in prime winter pelage remains to be determined.

Specimens examined.—Eight, all from the type locality.

Felis glaucula oaxacensis, subsp. nov.

Oaxaca Long-tailed Tiger Cat

Type.—From Cerro San Felipe, Oaxaca, Mexico (altitude 10,000 feet). No. 68169, male adult, skin and skull, U. S. National Museum (Biological Survey collection), collected by Nelson and Goldman, August 31, 1894.

Distribution.—Known only from the high mountains of Oaxaca.

General characters.—A small subspecies with marbled black and grayish markings. Related to *Felis glaucula glaucula* but larger; color tones similar but pattern quite different, and skull characters distinctive. Similar in general to *Felis glaucula nicaraguae*, but much smaller and grayer, and differing also in cranial details.

Color.—*Type:* Ground color of upper parts buffy gray, finely mixed with dusky from top of head over nape and along median dorsal area to base of tail, becoming clearer gray on sides; upper surface profusely spotted or striped with black, the spots very irregular in outline and differing in detail on each side of body those on flanks partially or completely encircling buffy grayish areas somewhat darker in tone than the interspaces and producing a marbled effect; top of head with six narrow, longitudinal black lines; black facial markings as usual in the group; nape with a narrow, interrupted median black line and two broad parallel lines; a narrow, elongated, black-bordered area extending from near median line over the shoulder in a diagonal curve downward and backward behind the shoulder to the abdomen on each side; back with two irregular central rows of elongated black spots extending to base of tail; under parts white, spotted with black across abdomen and inner sides of limbs; a heavy black bar across throat and two narrower broken bars across under side of neck; outer sides of forearms and hind legs buffy gray, spotted with black; feet buffy grayish, varied by small spots; outer sides of ears deep glossy black, edged with white, and with white submarginal median spots; tail above with broad, irregular black bands or spots and buffy gray interspaces, below marked with smaller black spots and whitish interspaces.

Skull.—Similar in general form to that of *F. g. glaucula*, but larger; nasals narrower posteriorly; interpterygoid fossa broader; auditory bullae smaller, less fully inflated; dentition similar, but upper carnassial relatively narrower. Compared with that of *F. g. nicaraguae* the skull is very much smaller; jugal relatively broader; nasals broader posteriorly; interpterygoid fossa narrower; dentition

lighter, the upper carnassial with internal cusp relatively smaller, and large upper premolar actually longer (antero-posteriorly) but decidedly narrower.

Measurements.—Type: Total length, 910; tail vertebrae, 368; hind foot, 130. *Skull* (type): Greatest length, 96.5; condylobasal length, 89.7; zygomatic breadth, 67.3; interorbital breadth, 17.8; length of nasals (median line), 18; greatest breadth of nasals (anteriorly), 13; greatest breadth of braincase, 44.4; breadth between tips of postorbital processes of frontals, 51.4; upper toothrow, exclusive of incisors (alveoli), 28.8; upper carnassial, crown length, 11.6, crown width, 4.8.

Remarks.—While the ocelots or short-tailed tiger cats are numerous in Mexico and Central America and a considerable number have been collected the few specimens available of the long-tailed tiger cats (genus *Margay* of Allen) indicate their comparative rarity. The present subspecies is based on a single beautifully-marbled adult male specimen. Subspecific relationship of *oaxacensis* to other North American forms of the group seems quite clear, but comparison with two adult males of *F. g. glaucula* from Los Masos, Jalisco, regarded as typical, with the type of *F. g. nicaraguae*, and with an adult female from Matagalpa, Nicaragua, brings out differential characters that warrant its recognition.

Felis glaucula yucatanica, subsp. nov.

Yucatan Long-tailed Tiger Cat

Type.—From Merida, Yucatan. No. 8612, skin only, U. S. National Museum, collected by Schott; entered in museum catalogue August 4, 1866.

Distribution.—The peninsula of Yucatan and northern Chiapas; limits of range unknown.

General characters.—Distinguished by very pale buffy grayish ground color. Similar in general to *Felis glaucula oaxacensis* but ground color decidedly paler with less dusky admixture, especially along median line from top of head to base of tail. Contrasting still more widely in color with *Felis glaucula nicaraguae*, which is ochraceous tawny between black markings over dorsum.

Color.—Type: Ground color of upper parts very pale buffy gray from top of head over nape and along median dorsal area to base of tail, becoming still paler and clearer gray on sides; upper surface irregularly spotted or streaked with black as usual in the group, the black spots on the flanks tending to encircle lighter areas; top of head with six narrow, longitudinal black lines; black facial markings as usual in the group; nape with a narrow median black line bifurcating posteriorly, and two broader parallel lines; median line of back with two more or less interrupted black lines, paralleled by a row of elongated black spots on each side; under parts white spotted with black across abdomen, inner sides of limbs and under side of neck; an interrupted black bar across throat; outer sides of forearms and hind legs very pale buffy gray, spotted with black; feet pale gray, dotted with small black spots; outer sides of ears deep black, edged with white, and with the usual white submarginal median spots; tail (incomplete) above with irregular black spots and pale, buffy gray interspaces, below marked with smaller black spots and dull white interspaces. A specimen from Tecpactan, Chiapas is similarly pallid in general tone but more buffy along the median line above.

Skull.—Characters drawn from a subadult female from Tecpactan, Chiapas as follows: Similar to that of *F. g. oaxacensis*, but nasals narrower posteriorly;

dentition heavier, the upper carnassials decidedly broader. Dentition approaching that of *F. g. nicaraguae* but interpterygoid fossa narrower, and nasals narrower posteriorly.

Measurements.—Subadult female from Tecpactan, Chiapas: Total length, 835; tail vertebrae, 382; hind foot, 120. *Skull* (of preceding): Greatest length, 90; condylobasal length, 84.1; zygomatic breadth, 54.8; interorbital breadth, 14.8; length of nasals (median line), 15; greatest breadth of nasals (anteriorly), 10.6; greatest breadth of braincase, 44; upper toothrow, exclusive of incisors (alveoli), 26.7; upper carnassial, crown length, 11.8.

Remarks.—Pallid coloration associated with the general aridity of the climate distinguishes a number of mammals of the Yucatan peninsula region, and the long-tailed tiger cat appears to be no exception to the general rule. In cranial characters the specimen from Tecpactan, Chiapas suggests close relationship to *F. g. nicaraguae* but lacks the rich color tones of the Nicaragua animal.

Peromyscus maniculatus assimilis, subsp. nov.

Coronados Islands Mouse

Type.—From Coronados Islands, off northwest coast of Lower California, Mexico. No. 77939, male adult, skin and skull, U. S. National Museum (Biological Survey collection), collected by A. W. Anthony, April 24, 1896.

Distribution.—Known only from the Coronados Islands.

General characters.—A large dark, richly colored subspecies closely resembling *Peromyscus maniculatus dubius* in external appearance, but skull exhibiting a departure in detail. Similar in size to *P. m. clementis* and *P. m. geronimensis*, but darker and cranial characters distinctive.

Color.—Type: Head and anterior part of back cinnamon brownish in contrast with posterior part of back and rump which are brownish cinnamon moderately mixed with black; flanks clearer cinnamon; under parts in general dull white, the plumbeous basal color showing through; inguinal region and small area at base of tail ochraceous buff; fore limbs whitish; outer sides of hind legs brownish with small dusky areas near heels, becoming whitish on feet; ears dusky, narrowly edged with white; tail sharply bicolor, brownish above, white below.

Skull.—Similar in size and general form to that of *P. m. dubius*, but rostrum more decurved and of lesser depth anteriorly, the frontal profile more convex near anterior roots of zygomata; fronto-parietal suture forming a less acute angle, the result being less median depth of emargination of parietals; outer walls of antorbital vacuities narrower as viewed from side, less projecting anteriorly, the zygomata less deeply notched as viewed from above; ascending branches of premaxillae reaching slightly farther posteriorly; interparietal narrower, less encroaching laterally on parietals along occipitoparietal suture; dentition about the same. Also similar in size and general form to skull of *P. m. clementis* but zygomata more squarely spreading anteriorly; antorbital vacuities opening more widely; outer walls of antorbital vacuities narrower as viewed from side, less projecting anteriorly, the zygomata less deeply notched as viewed from above; interparietal narrower, less encroaching laterally on parietals along occipitoparietal suture, fronto-parietal sutures similar; dentition about the same. Compared with that of *P. m. geronimensis* the skull is slightly heavier, with nasals

broader, interparietal longer (antero-posteriorly), and it differs otherwise in about the same characters as from *dubius*.

Measurements.—Type: Total length, 178; tail vertebrae, 80; hind foot (dry skin), 22.5. Average of five adult topotypes: 178 (172–182); 81 (79–82); 22.5 (22–23). *Skull* (type: Greatest length, 25.6; condylobasal length, 24.2; zygomatic breadth, 13; interorbital breadth, 4.2; interparietal, 8 x 2.8; length of nasals, 10; maxillary toothrow, 4.

Remarks.—The lesser depth of the zygomatic notch in specimens of the *Peromyscus* from the Coronados Islands, as compared with topotypes of *P. m. dubius* was pointed out by Osgood (North Amer. Fauna No. 26, p. 99, April 17, 1909). The specimens, however, were referred by him to *P. m. dubius*. Study of the same material has led us to the conclusion that the animal inhabiting the Coronados Islands possesses characters sufficiently distinctive to warrant a separate name. It requires no close comparison with *P. m. gambeli* of the adjacent mainland from which it differs in decidedly larger general size, larger, heavier skull, and much darker and richer color.

Specimens examined.—Forty-five, all from the Coronados Islands.

A NEW PIKA FROM IDAHO

By Adrey E. Borell

When Mr. Arthur H. Howell revised the American pikas (N. Am. Fauna, 47, 1924) he noted that the two available specimens of *Ochotona* from the Seven Devils Mountains of Idaho were not typical of the form *lemhi* with which he placed them. Study of a large series of pikas recently taken in the Seven Devils Mountains shows the existence of a distinct form which may be known and characterized as set forth below.

The proposed name is given in honor of Mr. Arthur H. Howell, of the United States Bureau of Biological Survey, whose "Revision of the American Pikas" is the basis for all future systematic work on this group.

Ochotona princeps howelli, subsp. nov.

SEVEN DEVILS PIKA

Type.—Adult male, skin and skull, No. 8744, Ralph Ellis collection; summit of Smith Mountain, Adams Co., Idaho, altitude 7500 feet (near head of Bear Creek, south end of Seven Devils Mountains); collected July 16, 1930, by Raymond M. Gilmore; original No. 1325.

Material.—15 adult males, 6 adult females, 5 immature specimens, from type locality, and one adult female and one juvenile female from Black Lake, Adams Co., Idaho; all taken during the month of July.

Diagnosis.—Size medium; hind foot large (see table of measurements); inside of ear blackish brown; nasals slender and emarginate posteriorly; palatal bridge narrow (antero-posteriorly); superior outline of skull longitudinally convex.

Comparisons.—When specimens of *O. p. howelli* are placed beside a series of adult specimens of *O. p. princeps* (12 from 15 miles northeast of Barkerville, and 7 from Michel, British Columbia) it is found that the two forms can be separated by the character of the nasals alone. The nasals of *princeps* are broadly truncate posteriorly, whereas the nasals of *howelli* are consistently narrow and emarginate posteriorly. In addition, the skulls of *howelli* have narrower palatal bridges, more nearly parallel sided basi-occipitals, and more spatulate interpterygoid fossae. As to color, *howelli* is similar to *princeps* but is grayer (less brownish) dorsally, ventrally and about the shoulders and sides; the ears inside are blackish brown rather than light buff.

O. p. howelli is a little larger and much darker in color both dorsally and ventrally than *O. p. lemhi*. The hind foot of *howelli* is actually and proportionately longer. The skulls of these two forms are similar, but *howelli* is proportionately broader interorbitally and has actually shorter nasals and narrower palatine bridges.

The main difference between *O. p. howelli* and *O. schisticeps jewetti* is in color. Specimens of *jewetti* are grayer about the head, and lighter over the back and rump. They are also more brownish (less grayish) ventrally and on the sides. The skulls of these two forms are hardly distinguishable. *O. p. howelli* has nasals which are slightly more constricted medially, and slightly broader basi-occipitals, but these characters overlap in some specimens.

The type specimen of *O. p. howelli* is deposited on loan in the Museum of Vertebrate Zoology, University of California, Berkeley. The twenty-five paratypes are in the Ralph Ellis collection, Berkeley, California.

Remarks.—Howell (*op. cit.*, p. 10) has grouped the American forms of *Ochotona* occurring south of Alaska into two species, namely, *princeps* and *schisticeps*, separated mainly on the basis of breadth (antroposteriorly) of palatal bridge; *schisticeps* is credited with being the smaller in this respect. However, an examination of the minimum and maximum palatal measurements as given by Howell (*op. cit.*) shows that this measurement often overlaps. This is the case with *O. princeps princeps* (1.6 to 2.7) and *O. p. lemhi* (1.7 to 2.5), on the one hand, as compared with *O. schisticeps jewetti* (1.3 to 2.4) and *O. schisticeps goldmani* (1.3 to 1.9) on the other. Also it is evident from Howell's revision and my examination that there is no other constant cranial or color character which definitely separates the two species. Howell (*op. cit.*, p. 41) questioned the relationship of the subspecies *O. s. goldmani* because it combines characters of the two species. Furthermore, it may be noted that, so far as is known, in no place do the forms of *princeps* and *schisticeps* occupy the same area, which they might do if the two forms were full species. Of greater significance still is the fact that the most noticeable overlapping of characters occurs in subspecies whose ranges are adjacent. They are, therefore, the forms in geographically logical areas for intergradation to occur. Finally, the average breadth of palatal bridge of *O. princeps howelli* is 1.7 millimeters (see accompanying table), whereas in 16 specimens of *O. schisticeps jewetti* from the Blue Mountains of Oregon, which is the next adjacent form to the westward, this measurement is 1.8 millimeters (*op. cit.*, p. 42) or more than that of *howelli* which clearly belongs to the *princeps* group.

Accordingly, it appears that all of the American forms of *Ochotona* except

collaris might better be placed with the species *princeps*, which was the name given to the first American species to be described (Richardson, Zool. Jour., Vol. 3, p. 520).

Average, minimum and maximum measurements[1] of three subspecies of Ochotona princeps

	TOTAL LENGTH	HIND FOOT	OCCIPITO-NASAL LENGTH	ZYGOMATIC BREADTH	BREADTH OF BRAIN CASE	INTERORBITAL BREADTH	BREADTH OF PALATAL BRIDGE	LENGTH OF NASALS
10 adult specimens of *howelli*	191.2	31.3	43.6	21.7	18.5	5.6	1.7	13.9
	182–205	29–33	41.1–44.7	21.2–22.5	18–19.4	5.2–6.1	1.5–2.1	13.5–15
10 adult specimens of *lemhi*[2]	178.7	29.5	42.1	20.6	17.3	4.9	2.0	14.1
			40.1–44.1	20–22	16.1–18.5	4.6–5.3	1.7–2.5	13.2–14.9
10 adult specimens of *princeps*[2]	191.6	30.5	43.0	21.3	17.9	5.4	2.0	14.2
	181–204	29–33	41.1–45.2	20.8–22	17.1–19.1	4.5–5.8	1.6–2.7	13.1–15.4

[1] All measurements in millimeters, taken according to method used by Howell (*op. cit.*, p. 7).
[2] As given by Howell (*op. cit.*, pp. 13, 17).

Contribution from the Ralph Ellis Collection, 2420 Ridge Road, Berkeley, California.

A NEW RACCOON FROM SOUTH CAROLINA

By E. W. Nelson and E. A. Goldman

Recent field work by the U. S. National Museum along the coast of South Carolina has resulted in the discovery of a new insular raccoon, which may be described as follows:

Procyon lotor solutus, subsp. nov.

Hilton Head Island Raccoon

Type.—From Hilton Head Island, Beaufort County, South Carolina. No. 256027, male adult, skin and skull, U. S. National Museum; collected by W. L. Brown, December 10, 1930.

Distribution.—Known only from Hilton Head Island, South Carolina.

General characters.—Size rather small; color grayish; black mask uninterrupted across face in two of three individuals; winter pelage rather long and dense. Similar in general to *Procyon lotor litoreus* of the adjacent mainland and neighboring islands, but color clearer gray, less inclining toward buffy or brownish; skull characters, especially the much lighter dentition, distinctive. Differing from *P. l. lotor* in smaller size, more grayish general coloration and cranial details.

Color.—Type: Upper parts in general grayish, rather heavily overlaid with black, especially on median dorsal area; rather small nape patch suffused with ochraceous buff; top of head mixed black and gray, the gray predominant; black mask continuous across middle of face, prolonged upward along median line to middle of forehead and downward over middle of muzzle to nose; sides of muzzle, lips and chin white; under parts in general thinly overlaid with silvery gray, the dark brownish under color showing through; throat patch blackish; ears gray, with black patches at posterior base; limbs similar to under parts, becoming brownish gray on feet, the hind legs with pure black areas on outer side above heels; tail with six black rings, narrowest near base, and a black tip, alternating with light ochraceous buffy rings.

Skull.—Skull of medium size, rather broad, short and light in structure. Similar in general to that of *P. l. litoreus* but smaller; dentition very much lighter. Compared with that of *P. l. lotor* the skull is shorter and relatively broader; frontal region usually broader and flatter; dentition usually somewhat heavier, but toothrow shorter as a rule.

Measurements (no body measurements available).—*Skull of type:* Greatest length, 111.7; condylobasal length, 108.2; zygomatic breadth, 75.1; interorbital breadth, 24.1; least width of palatal shelf (between last molars and interpterygoid fossa), 16.4; upper toothrow, exclusive of incisors (alveoli), 42.1; upper carnassial, crown length, 8.8, crown width, 9.2

Remarks.—The raccoon of Hilton Head Island is readily distinguished from *P. l. litoreus* of the adjacent mainland by much lighter dentition. Differentiation of this insular form is apparently due to isolation, its habitat being separated from the mainland by a broad and rather deep channel. Some skulls of this new form closely resemble some of those of *P. l. varius*, the general size and dentition being very similar. Closely compared with those of *varius*, however, the skulls are usually shorter and broader, the frontal region broader and flatter, the braincase more rounded and inflated, and the cheek teeth somewhat larger. In addition the longer pelage, grayer coloration, and more complete black facial mask, appear to be distinctive. The ranges of the two are separated by that of *litoreus*, and the resemblances noted should not lead to any confusion. The new form is based on nine skulls accompanied by three skins, all from the type locality.

A NEW VOLE OF THE SUBGENUS STENOCRANIUS FROM ALASKA

By E. W. Nelson

Mr. Gerrit S. Miller, Jr., has already directed attention to the fact that *Microtus miurus*, and its relatives, belonging to the subgenus *Stenocranius*, of the genus *Microtus*, represent another group of Asiatic mammals that crossed the great land bridge to Alaska. The present paper makes known another member of the group from Alaska.

The American range of *Stenocranius*, now known only from Alaska, is curiously similar to that of *Ovis dalli*. It appears obvious that the time of first occupation of this continent by both these voles and the white mountain sheep was much more recent than that of other representatives of *Microtus* and *Ovis* which now range south, respectively, to Guatemala and northern Mexico.

In the Annuaire du Musée Zoologique, St. Pétersbourg, Vl, p. 167, Prof. Kastschenko describes *Stenocranius* as a new subgenus of the genus *Microtus*, with *Microtus slowzowi*, Poljakoff, from Omsk, Siberia, as the type. Among other species of this group the author included *Microtus tianschanicus* Buchner and M. *eversmannii* Poljakoff, both from Central Asia, the last named from the Altai Mountains.

During the Smithsonian-Harvard Expedition to the Altai, in 1912, Mr. Ned Hollister collected a series of 8 specimens in the heavy pine forest at an altitude of 6875 feet, near Tapucha, which he identified as *M.* (*Stenocranius*) *eversmannii*. Another series of 31 specimens collected mainly on the treeless highlands between 9,000 and 10.000 feet, in the Tchegan-Burgazi Pass, represents *M.* (*Stenocranius*) *tianschanicus*.

Examination of the skulls of these series in the United States National Museum shows that, in common with *M. slowzowi* the enamel patterns of their molariform teeth agree closely with those of *M. arvalis*, of Europe, thus placing them definitely in the genus *Microtus*.

The skulls of members of the subgenus *Stenocranius* differ from those of the other subgenera of *Microtus* in being relatively lighter and proportionately longer, narrower and more flattened vertically; interorbital septum, in adults, usually narrower and more compressed to form a carinate ridge; zygomatic arches narrower and more flattened laterally; upper outline of skull more or less depressed in interorbital area; bullae more elongate-oval.

A number of species referable to this subgenus have been described from Central Asia, and Mr. Hinton has recorded its occurrence in the Pleistocene deposits of southern England.

In North America the group is now known only from Alaska, where it is represented by *Microtus a. abbreviatus*, *M. abbreviatus fisheri* and *M. innuitus*, large and rather aberrant forms from islands in Bering Sea; *M. m. miurus* and *M. miurus oreas* respectively from mountains on the Kenai Peninsula and from near Mt. McKinley and easterly along the Alaska Range to the head of Jarvis Creek; and the species here described, from the Endicott Mountains.

In his original description of *M. miurus* Osgood refers to the relationship between that species and the very distinct *M. abbreviatus* of Hall Island. It may be added that the last named, with *M. abbreviatus fisheri* from St. Matthew Island and *M. innuitus* from St. Lawrence Island, constitute a rather aberrant group of large forms within the subgenus.

Microtus muriei new species

ENDICOTT MOUNTAIN VOLE

Type.—From Kutuk River (Tributary of Alatna River) Endicott Mountains, Alaska. No. 243,482, ♀ adult, U. S. National Museum (Biological Survey Collection). Collected March 7, 1923, by O. J. Murie.

General Characters.—A well marked, small, short-tailed species, with heavy coat of long soft pelage; upper parts dusky drab-gray; under parts pale dingy buffy; ears small, hidden by fur; skull delicately formed, proportionately long and narrow; upper outline much flattened and strongly depressed over interorbital area. Color similar to that of *Microtus operarius* from which it is at once distinguishable by the short, thick tail and by skull characters.

Color.—Type: Upper parts practically uniform dusky drab-gray, darkened by overlying black tips of guard hairs; ears marked by small, indistinct buffy spots; back of hind legs and around base of tail dull buffy; underparts pale, dingy buffy; tail above dusky, below dull, pale buffy; tops of all feet dull, pale buffy.

Skull.—Very light, proportionately long and narrow; brain case and zygomatic arches flattened laterally with nearly parallel sides; rostrum proportionately long and narrow; upper outline of skull low and strongly depressed in interorbital area; interorbital septum rather broad on top lacking usual carination in this subgenus, possibly through immaturity; bullae symmetrically elongate-oval, their inner borders nearly parallel, not approaching anteriorly as common in the genus *Microtus*.

Measurements.—Type: Total length 119; tail vertebrae, 24; hind foot, 20; skull, condylobasal length, 24.3; zygomatic arches, greatest width, 10.7; brain case, greatest width, 9; nasals, length 6.5; rostrum, basal width, 4.

General Notes: The species of the subgenus *Stenocranius* appear to be high mountain animals. Hollister found *M. eversmannii* and *M. tianschanicus* in the elevated Altai region and in Alaska *M. miurus* and its subspecies, so far as known, occur only above timberline. Osgood caught the type series of *M. miurus* back of Hope, on the Kenai Peninsula, at burrows among short grass, in rocky soil, near the upper limit of vegetation. The burrows entered the ground on a level

with the runways in small hollows and basins in places where snow lies at all times except during a few months in summer. Charles Sheldon collected many specimens of *M. miurus oreas* about timberline near the head of the Toklat River, near the east base of Mt. McKinley, and O. J. Murie later took it farther east in the Alaska Range above timberline at the head of Jarvis Creek. Murie also captured the type of *Microtus muriei*, which is unique, above timberline in the Endicott Mountains. It appeared unexpectedly on the surface of the snow, and was caught under the webbing of one of his snowshoes.

There is a possibility that members of this group of voles may occur above timberline on the mountains of Yukon Territory and possibly in other parts of northern Canada, where search should be made for them.

This well-marked subspecies is named in honor of O. J. Murie, in recognition of his admirable work as a field naturalist in northern Alaska.

GENERAL NOTES

WATER-SHREW IN CONNECTICUT

A mounted specimen of a shrew from Hopkins Woods, Putnam, Connecticut, recently submitted to the U. S. National Museum for identification, was referred to me for determination. It proved to be *Sorex palustris albibarbis* (Cope), a male, and was collected September 20, 1930, by William Dearden. The animal was caught in a trap baited with cheese under a moss-covered bank on the edge of a brook. The specimen is in the Children's Museum, 609 Farmington Avenue, Hartford, Connecticut, and so far as I know constitutes the first record of this species for Connecticut, and the most southern record for New England.—Hartley H. T. Jackson, *U. S. Biological Survey, Washington, D. C.*

LONG-TAILED SHREWS IN NORTHERN INDIANA

While trapping about fifteen miles south of Notre Dame during the first week of March, 1931, I caught eleven specimens of *Sorex cinereus cinereus*. During this period the same trap line yielded but five other small mammals, two *Microtus pennsylvanicus pennsylvanicus* and three *Peromyscus leucopus noveboracensis*. The total absence of *Blarina* was especially noticed, since in trapping elsewhere about the county last year I found the short-tailed shrews so numerous as to be pests, as far as collecting was concerned. But the catch of the long-tailed shrews is interesting in itself, in view of the apparent scarcity of this mammal in Indiana. Hahn (Mammals of Indiana, 1909) noted that through several years collecting in the state he had never taken a single long-tailed shrew. I trapped rather extensively in the vicinity of Notre Dame from March to November in 1930 without success as far as this species was concerned. There are but five published records of *Sorex cinereus cinereus* from Indiana, four from Porter county, taken by Dr. Marcus Ward Lyon, Jr., and one from New Harmony.—William L. Engels, *Univ. of Notre Dame, Notre Dame, Ind.*

PROTECTION AGAINST VAMPIRE BATS

One of the problems to be met when travelling or collecting in tropical America is the injury done to horses and mules by the vampire bat (*Desmodus rotundus*).

My own experience with these bats has been limited but it may prove helpful to others who find themselves in the same position.

While on the Captain Marshall Field Brazilian Expedition of the Field Museum of Natural History I was camped on part of the Descalvados Ranch on the Upper Paraguay River in the State of Matto Grosso, Brazil. I was trying to collect a group of marsh deer (*Blastocerus dichotomus*) which were rather common in this place, as were also vampire bats. My four horses suffered so from the attacks of these bats that my Indian guide said we would have to move or in a short time the horses would be too weak to use.

The only protection he could suggest was to rub the horses with jaguar grease. I first tried covering the horses with cheesecloth as I thought the feel of something strange might keep the bats away. The horses were white so the color of the cloth was not an added attraction. It was no protection, however, as when I looked at the horses at eleven o'clock there were eight bats on one horse. It then occurred to me that as the bats were only about at night, a strong light might keep them away.

The next evening I hung a Coleman Gasoline Lantern to the limb of a tree about twenty feet from the ground and stretched a picket line under it, to which we tied the horses. Bats could be seen flying about the edge of the lighted area but they would not enter it and the horses were not touched again during the month spent at that camp. The lantern, which burned each night until dawn, used between three and four gallons of gasoline in a month.—Colin Campbell Sanborn, *Field Museum of Natural History, Chicago, Illinois.*

BAT OIL FOR RHEUMATISM

While collecting in the southern part of Indiana, in 1930, I visited the justly celebrated Marengo Cave, in Crawford County, on September 2. The guide who took us through said, at that time, the bats were just beginning to return from their summer excursion. In winter, large numbers of bats were said to hibernate in the cave which has a temperature the year around of 56°F. We saw only one bat, which the guide kindly picked off the wall of the cavern and gave to me. I killed it and on emerging from the cave made it into a skin. It was given to the United States National Museum, where it was identified by Mr. Gerrit S. Miller, Jr., as the common *Myotis lucifugus*. The guide told us that one man who had visited the cave a few years back, had asked him to collect a large number of bats, which he did. He said this person had tried out the oil and used it for rubbing on his rheumatic joints. The treatment was so successful that he had written in for a second supply of bats. Many kinds of animal oil have been recommended for rubbing on rheumatic joints, but bat oil was new to me. I wonder if others have heard of similar use being made of it. Of course, there is no more virtue in bat oil than in any other animal oil. In fact, the only virtue in rubbing oils lies in the massage given at the same time. In making up the skin of the bat collected in Marengo Cave, I gained the impression that it was exceedingly fat, there being large subcutaneous masses of adipose tissue. These became more or less liquid by the warmth of my fingers, so that probably a high percentage of olein was present. Bats apparently become fat before hibernating after the manner of other animals.—Marcus Ward Lyon, Jr., *South Bend, Indiana.*

LITTLE SPOTTED SKUNK, SPILOGALE GRACILIS SAXATILIS, RECORDED FOR MONTANA

A spotted skunk was trapped in Tin Cup Canyon, Ravalli County, Montana, November, 1929, by E. J. Kerlee of Darby. This specimen was an adult male measuring: Total length, 16.2 in.; tail, 5.4 in.; hind foot, 2.4 in. Identification as *Spilogale gracilis saxatilis* (Merriam) was verified at the United States National Museum.

The animal was collected in the foot hills of the Bitter Root Mountains, about twelve miles east of the divide forming part of the Montana-Idaho boundary. No other reports of spotted skunks in this district or records for the state could be obtained.

If this record indicates the establishment of the species rather than a stray individual it extends the range of the genus as given by Anthony in his Field Book of North American Mammals, 1928.—WILLIAM L. JELLISON, *Hamilton, Montana.*

HARBOR SEAL IN NORTH CAROLINA

During the last week of February, 1931, a crew of fishermen from Morehead City, North Carolina, captured a harbor seal, *Phoca vitulina*, in the lower part of Pamlico Sound, near Ocracoke. It was taken to New Bern, N. C., shortly after its capture, and was kept there alive until purchased by the State Museum at Raleigh, where it was received on April 7, after having been in captivity about five weeks.

The seal was blind in both eyes when secured, though it seemed healthy and was quite fat when received at the Museum. It was said to have eaten ten herrings at one meal just before being shipped.

Complete blindness seemed to be indicated when examined at the Museum, and a further examination showed one eyeball ruptured and the other opaque over the whole of its external surface.

The man from whom the specimen was purchased told us that in the early part of last winter a man shooting from a goose-blind at Ocracoke had seen and shot at a seal, and he asked us to examine the head of our specimen, after skinning it, for shot wounds. We found four shot that appeared to be about number four in size imbedded immediately beneath the skin or in the muscles of the head, one of them being found in the region of the lower eye-lid that covered the ruptured eyeball.

Our specimen is a male; it measured 3 feet, 10 inches in total length, and weighed 50 pounds; the condition of its teeth indicated a young animal, though seemingly adult.

We have two other records of the harbor seal on the coast of North Carolina, one—of which the Museum has the skin—taken in the estuary of Neuse River in the early eighties of the last century, and the other killed by a man from New York on Judith Island, Pamlico Sound, in 1898. This last was not preserved, though I believe the record to be reliable.—H. H. BRIMLEY, *Director, North Carolina State Museum, Raleigh, N. C.*

A FROG-EATING CHIPMUNK

On August 6, 1930, while standing on the shore of Half-moon Pond, not far from Peterboro, New Hampshire, I made an interesting observation on the food-habits of the Chipmunk (*Tamias striatus lysteri*). Some instructors in Boston

University Sargent Camp called me in time to see the frantic struggles of a small bullfrog (*Rana catesbeiana*) which they had seen the chipmunk capture. Not more than six inches from the shallow water, into which the chipmunk had made a dash to catch one of the numerous young frogs, he was sitting, eagerly devouring the frog which was still kicking violently. With great deliberation, and with no apparent fear of the number of persons who soon came to see the unusual performance, the chipmunk chewed away at the anterior end of his prey, the half-grown bullfrog struggling with the other end. I watched this strange feeding process of the chipmunk for fifteen minutes. In that time he finished eating the frog, bones and all. To catch the young bullfrog the chipmunk went out into the shallow water at least fifteen inches.—Earle A. Brooks, *Newton Highlands, Mass.*

OCCURRENCE OF THE GOLDEN-BREASTED CANYON MOUSE IN WYOMING AND UTAH

While making a study of the distribution of mammals in northeastern Utah and the adjacent parts of Wyoming, we collected two series of golden-breasted canyon mice (*Peromyscus crinitus auripectus*). The first series was taken during the summer of 1928 from a rocky talus slope bordering Sheep Creek, ten miles south of Linwood, Utah. Several of the mice were captured alive and shipped to the Murarium at the University of Michigan, where one was still alive in June, 1930. In spite of the fact that mammals were collected in this general area all summer, no other specimens of this mouse were obtained.

During the summer of 1929, another series of this species was taken among the rocky cliffs of Henry's Fork, one mile north of Linwood. Since Linwood is practically on the Utah-Wyoming state line, these mice were collected in the state of Wyoming. The habitat was the same type as that in which the mice were captured during the previous year.

Osgood (North Amer. Fauna, No. 28, p. 231. April 7, 1909), gives the distribution of this species as follows: "known from a limited number of localities in northeastern Arizona, southeastern Utah, and adjacent parts of Colorado and New Mexico." Cary later mentioned the species "among the characteristic Upper Sonoran mammals of the Green River Valley," Wyoming (North Amer. Fauna No. 42, 1917, pp. 19 and 25).

Further collecting in the Green River Valley both in Southwestern Wyoming and northeastern Utah, will no doubt increase our knowledge of the range of this mouse. The valleys of the Green and Colorado Rivers should prove fruitful grounds for mammal collectors, since this region is evidently little known.

From our experience with this mouse it seems to be limited in its habitat to rocky cliffs along the river canyons and is not found in large numbers even there. The white-footed deer-mouse (*Peromyscus maniculatus osgoodi*) occurred in the same region and habitat, but far more abundantly.—Arthur Svihla and Ruth Dowell Svihla, *Chas. R. Conner Museum, Pullman, Wash.*

ACORNS STORED BY PEROMYSCUS CALIFORNICUS

For a long time I have heard rumors of noises made by some small animals at night around houses in or near the woods, and recently my friend Burt Owens of Ben Lomond in the Santa Cruz Mountains has succeeded in connecting the noises with one of the animals that was responsible for them. Something had been storing the long acorns of the live oaks in every conceivable nook and corner about the

house and grounds, even to filling an old shoe with the big nuts that really seemed too heavy for a mouse to handle. I suspected that woodrats were the storers but one night Mr. Owens, with the aid of a flash light, watched a big mouse carrying and hiding the acorns and by setting a trap caught the mouse and brought it with some of the acorns to me for identification. It proved to be the big eared California white-footed mouse, *Peromyscus californicus*, the largest of its group and one of the most beautiful and interesting of our native small mammals.

The fact that these mice store acorns and other nuts and seeds where many will remain unclaimed to grow and spread the forest, places them in a class of useful rodents that should have a recognized place in the economy of nature. They may gather and eat great numbers of the seeds of trees and other plants but if a few of those stored remain where they will grow and help to extend the forest the millions of seeds lost will count for but little.—CLARK P. STREATOR, *Santa Cruz, California.*

A FLY-EATING MOUSE

In a show window of a mineral company of Sierra Blanca, Texas, August 21, 1929, I saw a mouse (*Mus musculus*) running about among the ore samples piled in the window. Upon close observation, I discovered it to be catching and eating house flies (*Musca domestica*). The room had previously been used for storing fresh vegetables, but at this time it was devoid of all food. This fly-catching game was probably the only means of avoiding starvation.

While I was watching for a period of about ten minutes, the mouse caught and devoured a dozen or more flies and was still working hard for more. The rock ore was piled against the window glass, and when the flies, buzzing along the glass in an attempt to escape, got within a few inches of the mouse, it would dive for them. The attempts of the mouse were about ninety per cent successful. My presence and motions against the glass on the outside were unheeded by the mouse.

It would be interesting to know to what extent other rodents feed upon harmful insects, either under normal conditions or because of necessity.—SHALER E. ALDOUS, *Junior Biologist, U. S. Biological Survey.*

A MINOR PLAGUE OF HOUSE MICE AT DAVIS, CALIFORNIA, IN 1926

During the summer and autumn of 1926 several reports were received in Davis concerning the unusual prevalence of the house mouse (*Mus musculus*). At the time the subject was of local interest, but this local increase coincided with the conspicuous abundance of the species in Kern County, California,[1] 250 miles to the south. I am led, therefore, to wonder whether some factor was operative over a wider area to give *Mus musculus* a favorable opportunity for increase in that year. Only a few details of the local outbreak were recorded: 19 were caught in 3 weeks in a single trap set in the zoological laboratory; all were young individuals and none contained embryos. One resident of Davis caught 14 in one day in 3 traps, repeatedly set. Another took 115 in her house between July 5 and the end of November. Still another resident, on the opposite side of the town, re-

[1] Hall, E. R., Univ. Calif. Publ. Zool., 30, 1927, pp. 189–203; Piper, S. E., Mo. Bull. Calif. State Dept. Agric., 17, 1928, 538–560.

ported more than usual difficulty with house mice in stored poultry feed. Between 35 and 40 were trapped in the bee house on the campus during May and June. Mice were also unusually numerous in a small building housing poultry used in studies on poultry parasites.—TRACY I. STORER, *University of California, Davis, Calif.*

COMMUNITY NESTS OF THE HOUSE MOUSE

During the winter and early spring of 1931 the Animal Science Building on the University Farm campus at Davis, California, became infested with house mice (*Mus musculus*). This building, of reinforced concrete, constructed in 1928, has all ventilators screened with hardware cloth of ¼ inch mesh or with fly screen, but a few small windows were, through oversight, left unscreened. Special precautions were taken to protect food stuffs against rodents, and no mice were present in the ensuing two years. In the autumn of 1930 a colony of rabbits was established in the basement and the food for these attracted house mice which rapidly increased in numbers, a total of 119 having been trapped during February and March.

On February 11 a "community nest" was found that harbored 36 young. Of these one brood was newly born, another of a size ready to leave the nest, and the remainder of intermediate development, with the eyes still unopened. I did not see this nest, so have not full details as to the number of litters represented. On March 26 another such nest of paper and hay was discovered in the corner of a box containing alfalfa. One brood of 7 had been born within the preceding 24 hours; 10 others were well haired but with eyes unopened. These latter were all of nearly the same size so I am uncertain as to whether they represent one or two litters.—TRACY I. STORER, *University of California, Davis, Calif.*

SWIMMING OF THE MUSKRAT

In the Journal of Mammalogy, vol. 12, 1931 is an excellent paper on the muskrat. On pp. 15–16 mention is made of its swimming but apparently not from actual observation. In fact no such observation is possible in its usual habitat.

The old Loch Raven was made by a breastwork across Big Gunpowder Falls which backed the water about four miles up stream. Along both sides ran a driveway with little marble bridges across the small streams. One side was in constant use but the other was not opened at either end. This was a favored walk of mine. One of these streams, rising in the wooded hills at the head of Dulaney Valley and flowing mostly through grassland, entered Loch Raven as perfectly clear water about 2 feet deep and 12 feet across. Many an hour have I rested on the bridge and watched the muskrats below within six feet of me as they swam back and forward under the bridge.

The fore paws were held close together, palms outward and pressed close up under the chin as if to protect the throat from the water while the powerful hind feet and legs worked *alternately*. This gave the spine at the rump a cross see-saw motion which extended to the tip of the tail in a wavy motion in which I could detect no propulsory power. The direction, right or left, up or down, was caused by the angle at which the stroke of the hind foot was given and a corresponding movement of the front part of the body. While the back was always up, a lateral view could be had when they got a little way from below me. In entering the

water, if not scared they went in just as a dog might but if startled they dived in head first and no doubt used both hind feet similtaneously for the spring.

The only use I ever saw the fore paws put to was in washing a piece of root brought to the bank in the mouth. Here while sitting on hind feet, the root was dipped in the water, rubbed between the palms, dipped and rubbed again and then minutely inspected and if a speck of dirt was discovered washed all over again. I have seen this done several times before the root was eaten, the fore paws being used as a squirrel does.—FRANK C. KIRKWOOD, *Phoenix, Baltimore County, Maryland.*

THE MUSKRAT'S OFFENSIVE DEFENSIVE

Arthur and Ruth D. Svihla in their paper on the Louisiana Muskrat in the February number of the Journal speak of muskrats fighting desperately when caught or cornered, "jumping and striking at their opponents, regardless of size." As is well known, this is a habit of the northern muskrat also. Dr. Charles E. Johnson in "The Muskrat in New York" (Roosevelt Wild Life Bulletin, vol. 3, no. 2), discussing the muskrat's attacks on man, often seemingly unprovoked, says: "While attacks of this sort have the appearance of being unprovoked it is possible that near approach to the muskrat at such times is in itself sufficient provocation to cause the animal to defend itself by attack. Being far removed from its natural protective element it doubtless is in a state of uneasiness and high irritability." I believe that this view of Dr. Johnson's is the correct one. In April of last year, as a friend and I were crossing a country road in Sharon, Massachusetts, we saw a muskrat ambling slowly towards us down the road. It stopped when about five yards away, having then apparently just caught sight of us. I took a step or two towards it, but when it made a dart at me, stepped aside. My companion, however, advanced toward it, rather incautiously in spite of my warning, and just escaped a rush at his leg. The animal then trotted off among the trees and shrubs beside the road and stopped there, making two or three short sallies when we approached it; and we finally left it in peace. On thinking over the occurrence in the light of accounts of similar behavior on the part of the muskrat of which I had heard and read, I came to the conclusion that this was a purely defensive reaction and not due to any inherent bloodthirstiness; and it occurred to me that an active defense of this nature was perhaps the only safe course for a slow-moving animal that lacks any such special defensive equipment as those possessed by the skunk and the porcupine. A reputation for ferocity would doubtless be of great survival value to an animal without either protective armor or a battery of poison gas, and without speed enough to escape from its enemies by running away. An offensive defensive would seem to be the natural one for the muskrat.—FRANCIS H. ALLEN, *West Roxbury, Mass.*

A PREGNANT PORCUPINE

A rather unusual situation for a female porcupine (*Erethizon dorsatum dorsatum*) about to give birth to her young was discovered in Tamworth, New Hampshire, on May 25, 1930. The porcupine was resting fifty feet up in the branch of an elm tree which grew in the middle of a wide, inundated, swampy region overgrown with grass and low bushes. A day later, on May 26, it was found still in the same place. When shot, the porcupine weighed exactly 12 pounds and on

dissection its stomach was found to be full of elm leaves. Further investigation revealed a mature foetus weighing one and a quarter pounds, well covered with black hair and short, half-inch quills. Both adult and foetus are now in the Museum of Comparative Zoology at Cambridge.

The body of the mother porcupine was swarming with internal parasites. These were collected for the museum and included a tapeworm (*Schizotaenia americana*), an oxyuroid nematode (*Wellcomia evoluta*), and a female filariid nematode (unidentified). The only external parasite found was a Mallophaga (*Trichodectes setosus*).—LAWRENCE KILHAM, *Boston, Mass.*

INDIANA'S SWAMP RABBIT

After being the subject of conjecture and prognostication for some fifty years, the swamp rabbit, *Sylvilagus aquaticus aquaticus*, Bachman, has now definitely taken its place in the fauna of Indiana. A collection of mammals, made possible by the support of the Indiana Department of Conservation and the Museum of Zoology of the University of Michigan during the summer of 1930, contains four specimens of this species.

Coues and Allen, 1877, quote E. W. Nelson as follows: "*Lepus aquaticus* is abundant in the canebrakes near Cairo and Mound City, Illinois, and doubtless extends as far up the Ohio as the mouth of the Wabash, at least."

Dr. Amos W. Butler, in 1895, wrote, "Mr. Chansler says a brown rabbit has been seen there (Knox Co.) by different persons. It is said to be much larger than the common gray rabbit. It seems probable that two forms of swamp hares will be found in the Lower Wabash valley, the one above noted, which ranges southwest to the Gulf of Mexico, and the smaller, *Lepus palustris*, Bachman, which ranges to the south and southeast." However, more complete evidence than was available at that time now shows that *Sylvilagus palustris* must be ruled out.

Hahn, 1909, gives *Lepus aquaticus* a provisional place in the fauna. He quotes Mr. Chansler of Knox County to the effect that though seen in 1894 and 1898 they were rare and no specimens were taken. We were unable to verify their occurrence in Knox County, but they may have disappeared with the drying up of the swamps and marshes which Mr. Chansler says may have caused the disappearance of *Oryzomys*, which he believed to have been there at that time.

All of our specimens were taken in Point Township, Posey County, the very tip of southwestern Indiana, and appeared to be closely confined to the canebrakes, which are now but a sad remnant of those that once occupied this region. We do not know the extent of their distribution in Indiana, but it seems possible that they may occur around Pitcher Lake, on Big Island in the Wabash, in the wet sloughs above Mt. Vernon along the Ohio River, and may even occupy the canebreaks near Yankeetown, a few miles up the Ohio from Evansville.

Of its habits, Bachman (1837) states: "Occasionally seen on high ground in thick woods, yet it prefers low swampy places, where it can have access to streams and ponds of water . . . . ." The cane where this rabbit was found in Indiana forms a dense, almost impenetrable undergrowth in thick woods, composed in part of hickory, walnut, pecan, sweet gum, swamp cottonwood, and various oaks. The ground is low and portions are covered with water during the wet season. The cane which apparently cannot grow in water is confined to low, narrow, knoll-like

ridges. During the summer of 1930 these places were completely dry due to an almost rainless summer.

The range of this form according to Nelson, 1909, is as follows: "River bottoms and swampy woods from Lumpkin, southwestern Georgia, west to Medina River near San Antonio, middle Texas, and north at least to Hartshorne, Oklahoma, and to the wooded bottoms of the Ohio and Mississippi rivers in Southern Illinois; . . . ." He records four specimens from Olive Branch and one from Reevesville, Illinois, the latter place only about thirty miles south of Point Township, Indiana.

Despite the very different appearance of this swamp rabbit from the common rabbit, *Sylvilagus floridanus mearnsi*, it is but little known to local residents. This would indicate that it is fairly scarce and rather closely confined since its large size, coarse, dark hair, and comparatively short ears, easily distinguish it.

The data on our specimens (measurements being in millimeters) are as follows:

Cat no.	Total length	Tail	Hind foot	Ear	Weight
(P.H.) 11	523	52	113	71	2474 gms.
(P.H.) 23	510	55	113	72	2155 gms.
(P.H.) 120	402	40	100	69	1927 gms.
(T.H.) 5	414	53	98	66	1409 gms.

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—Thomas Harrison, *Purdue University*, and P. F. Hickie, *University of Michigan*.

THE NAME LORICATA

In Dr. G. G. Simpson's excellent new classification of mammals (Bull. Amer. Mus. Nat. Hist., LIX, March, 1931) I find the infraorder Loricata Owen, 1842, for the Dasypodidae and two extinct families. But the name Loricata (as an Order) applies to the crocodilian reptiles, and was proposed by Merrem in 1820. Hence it will apparently be necessary to use the name Hicanodonta Ameghino, 1889, for the mammalian group.—T. D. A. Cockerell, *University of Colorado, Boulder Colorado*.

THE MANATEE IN NORTH CAROLINA

I appreciate the fact that this record has been much delayed; but I do not think it has been given publicity before, except in the local Raleigh and Wilmington papers at the time of its occurrence.

The specimen was caught by fishermen in Masonboro Sound, near Wilmington, North Carolina, on September 11, 1919. It was taken overland alive to Greenfield

Park, a resort near the city of Wilmington, where it was placed in a wire netting pen built in the lower end of the lake. It finally died during the first cold spell in the following November, the exact date not being known. The body was skinned and buried and the skin salted down, the latter coming to the State Museum the following year. Efforts to secure the skeleton have been unsuccessful as all persons connected with its burial had moved away when the attempt to secure it was made.

This manatee measured seven feet, two inches in length and was estimated to weigh about 700 pounds. While confined in the lake it first ate all the water-growth within reach and then eagerly absorbed collards, carrots, light-bread and other vegetable food, showing a particular partiality for bananas.

It was out of the water about six hours while being transported from Masonboro Sound to Greenfield Lake, without apparent injury. Thousands of people viewed the specimen during the (approximately) two months of its captivity.—H. H. Brimley, *Director, North Carolina State Museum, Raleigh, N. C.*

AMOUNT OF CARBON DISULPHID NEEDED IN FUMIGATING MUSEUM CASES

Carbon disulphid is regularly and successfully used to fumigate museum cases containing skins of birds and mammals, but there seems to be no statement on record as to the amount required to accomplish effective fumigation. A single experiment along this line performed by the writer may therefore be of interest to museum curators.

Four air-tight zinc-lined cases, each measuring $43\frac{3}{4} \times 42\frac{3}{4} \times 26\frac{3}{4}$ inches, outside, were used. Each contained ten or more shallow trays filled with study skins of small mammals. The net volume of each case, after deducting for the trays and framework but not for the specimens, was about 25 cubic feet.

A number of Tineoid (clothes) moths were caught and confined in glass vials, a firm pledget of non-absorbent cotton used as a stopper in each vial. Three vials were put into each case, one each in the top, middle and bottom trays. Carbon disulphid was placed in a shallow dish in the topmost tray of each of three cases; one-half ounce (fluid) in the first, one ounce in the second, one and one-half ounces in the third. The fourth case was left as a control. The experiment was started at 3 p.m. one day and the cases were opened at 10 a.m. on the day following. *All* of the moths in the fumigated cases were dead, while all of those in the control case were alive, and remained alive for some time and were used in another experiment.

This test would indicate that carbon disulphid at the rate of one-half ounce per case of the size indicated (slightly larger than the U. S. National Museum "quarter-unit") or at 20 fluid ounces (1.68 pounds) per 1000 cubic feet of space is a safe minimum dose for museum material. Thus 32 cases of the size indicated could be treated with one pint of material. Stored grain products are often treated with carbon disulphid to kill insects infesting the grain; the dosages recommended are much higher (4, 5 and even up to 20 pounds per 1000 cubic feet) because of the less perfect closure of the storage bins, denseness of the grain masses and actual greater resistance of some of the insects concerned. (See Hinds, W. E., U. S. D. A. Farmers' Bull. 799, 1922; Wardle and Buckle, 1923, Principles of Insect Control, pp. 194, 195).

The effective use of carbon disulphid requires that the fluid be placed in shallow

dishes at the top of a case; most rapid evaporation and diffusion occurs when the surrounding temperature is 70°F. or higher. Thus daytime rather than overnight fumigation is indicated, especially in the colder months of the year.—TRACY I. STORER, *University of California, Davis, California.*

RECENT LITERATURE

Nelson, E. W. WILD ANIMALS OF NORTH AMERICA: INTIMATE STUDIES OF BIG AND LITTLE CREATURES OF THE MAMMAL KINGDOM, WITH ILLUSTRATIONS FROM PAINTINGS BY LOUIS AGASSIZ FUERTES AND DRAWINGS OF TRACKS BY ERNEST THOMPSON SETON. Published by The National Geographic Society, Washington, D. C., 1930. 8 vo., pp. 1–254, frontispiece, 108 colored and 95 halftone illus. in text. Cloth $4.

The 1930 edition of Nelson's "Wild Animals of North America" is as truly the result of an evolutionary process as are the subjects portrayed. In response to a popular demand the work was first published as two entire numbers of the National Geographic Magazine. One of these comprising "The Larger Animals of North America" was the issue of November, 1916; the other, devoted to the "Smaller Mammals of North America" followed in May, 1918. The text and the excellent colored illustrations by Louis Agassiz Fuertes, sketches of tracks by Ernest Thompson Seton, sketches of extinct species by Charles R. Knight and others, and numerous fine photographs were then combined without rearrangement in a volume under the above title. Although the lack of orderly sequence was an inconvenience the 1918 edition has been exhausted.

In the new edition the animals are rearranged in systematic order. The subject matter and illustrations remain essentially the same but suitable introductions to groups have been added as illuminating chapter headings by the author and a few remarkable photographs are new. A noteworthy feature is the wealth of illustrations depicting the animals in natural habitats which with the text convey to the reader, *almost* a clearer concept of the mystery of their lives. There is a foreword by Gilbert Grosvenor and a complete index.

In this finished product we have satisfactory, concise, popular but scientifically accurate biographies of the principal mammals of North America in convenient form for use. Some idea of the enhanced value of the revised edition may be gained by the enconiums brought forth by the older version, especially the appraisal of Theodore Roosevelt which runs in part as follows: "The book is of first-rate importance. Mr. Nelson . . . . is one of the best and keenest naturalists we have ever had, and a man of singularly balanced development . . . . this is a book which should be read and owned by all, for it is of both present and permanent value."—E. A. GOLDMAN.

Osborn, Henry Fairfield. COPE: MASTER NATURALIST. THE LIFE AND LETTERS OF EDWARD DRINKER COPE. WITH A BIBLIOGRAPHY OF HIS WRITINGS CLASSIFIED BY SUBJECT. xvi + 740 pages, illus. Princeton Univ. Press, Princeton, N. J. 8 vo. 1931. Cloth $5.00.

With a sympathetic understanding acquired through years of personal contact

not only with the man himself, but also with his materials, Professor Osborn has written a fascinating biography of America's "Master Naturalist." Following an excellent sketch of the pioneers of American Paleontology, which serves as a background for what follows, the colorful story of the life, discoveries, and philosophy of Edward Drinker Cope (1840–1897) is traced in chronological order.

Being born of Quaker parents, Edward Drinker Cope received a rigid training in matters of conduct, manners, and religion during his boyhood years. He was taught to observe and estimate the worth of life in the barnyard and fields, and "his mind reached in every direction for knowledge, seizing upon everybody who came in his way, as a source or else a receptacle of information, which he was as ready to impart as to receive." In his ninth year, young Cope was sent to a Quaker day school in Philadelphia, where he had an opportunity to visit the museum of the Academy of Natural Sciences. The interest aroused by contact with this collection persisted through the following years when he was attempting to master the scientific and practical side of farm life at the earnest solicitation of his father. Letters written by Cope to members of his family show that he had evinced an active interest in natural history at the age of six, and at the age of twenty we find him lamenting the fact that farm life kept him so physically tired that he had to neglect the more interesting pursuit. "Fortunately for science, Alfred Cope acceded to his son's desire to attend Dr. Joseph Leidy's course in comparative anatomy at the University of Pennsylvania," and during the ensuing two years he was busily engaged in recataloging the herpetological collection of the Academy of Natural Sciences. In conjunction with the latter work several visits were made to the Smithsonian Institution. Cope's father then sent him to Europe where he remained during 1863 and 1864. His letters show that he was keenly appreciative of the benefits of European travel. On his return from Europe, he received an appointment at Haverford College as professor of zoology. Following his marriage to Annie Pim in 1865, Cope began a series of professional journeys, the results of which are embodied in his early papers on the amphibians of the Ohio coal measures, the Cetacea, both recent and fossil, the cave fauna, and the fossil reptiles of New Jersey.

In the autumn of 1871, Cope visited the Cretaceous marine deposits of Kansas, and in the succeeding years he explored various fossil beds in Wyoming, Colorado, New Mexico, Montana, Texas, Oregon, and Utah. Exceedingly interesting descriptions of pioneer fossil hunting in the west, frequent comments on distinguished men of the period, unusual incidents that occurred during his various trips, difficulties arising during his employment by the Hayden and Wheeler Surveys, illuminating side-lights on the famous Marsh-Cope controversies, and numerous intimate details of his own private life are interspersed in a series of letters to his wife, daughter, father, sisters, and brother. Beginning with the concentration of the Hayden, Powell, Wheeler, and King Surveys into the new United States Geological Survey on March 21, 1879, Cope not only lost government support for his work, but was also hard pressed for funds to carry on his own work. Cope's correspondence clearly shows how his activities were hampered by a series of financial reverses which were the result of ill-advised mining investments. "The decade 1870 to 1879, as he was passing from his thirtieth to his thirty-ninth year, was the golden period in Cope's life: the period of his greatest achievement, of his incomparable western explorations, of the acquire-

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THIRTEENTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF MAMMALOGISTS

The thirteenth annual meeting of the American Society of Mammologists was held at the Academy of Natural Sciences of Philadelphia from May 12 to 15, 1931, with about 70 members in attendance.

PROGRAM

(Papers marked with an asterisk (*) were illustrated by lantern slides; those with a dagger (†), by motion pictures.)

TUESDAY, MAY 12

8.30 *p.m.*

Meeting of the Board of Directors at the Robert Morris Hotel

WEDNESDAY, MAY 13

9.30 *a.m.*

1. *Notes on the life history of the agouti. R. K. Enders.
2. *Results of attrition of incisors in hares. Albert R. Shadle.
3. *Notes on unrecorded species from Connecticut. Geo. G. Goodwin.
4. *Random Notes on New England mammals. Francis Harper.
5. *Animal life of the Mississippi Wild Life Refuge. Vernon Bailey.
6. *The origin of the mammalian palate and jaw. W. K. Gregory.
7. *Collecting mammals in Madagascar. Richard Archbold.

1.30 *p.m.*

Annual business meeting of the Society

8. †The muskrat in Ohio. R. K. Enders.
9. †The year round. R. M. Anderson.
10. †Sanctuary. R. M. Anderson.
11. †Life of the beaver. R. M. Anderson.
12. †Bison and beavers. Wharton Huber.
13. †The birth of the monkey; development of the monkey egg. Carl G. Hartman.

8 *p.m.*

14. †In quest of gorillas. H. C. Raven.

THURSDAY, MAY 14

15. *Geographical variation within two subspecies of *Peromyscus maniculatus*. Lee R. Dice.
16. Report of the Society's special committee on problems of predatory mammal control. H. E. Anthony.
17. *Experiments in reëstablishing muskoxen in Alaska. W. B. Bell.

12.30 *p.m.*

At the conclusion of the morning session the members were transported by bus to the Zoological Garden, where they were guests at luncheon of the Zoological Society of Philadelphia and the Academy of Natural Sciences of Philadelphia. After luncheon they were conducted by officials of the Zoological Society on a tour of the Zoological Garden.

7.00 *p.m.*

Annual dinner of the Society

After the dinner the following motion pictures were shown:

18. †Expeditions of the Academy of Natural Sciences of Philadelphia to Alaska and Greenland. Harry Whitney.
19. *†The Morden-Graves Expedition of the American Museum of Natural History to Turkestan and Siberia. Geo. G. Goodwin.
20. †Animal life of the New Jersey coast, past and present. J. Fletcher Street.

FRIDAY, MAY 15

9.30 *a.m.*

21. *Experimental production of malocclusion in hares. Albert R. Shadle.
22. Bat oil for rheumatism. M. W. Lyon, Jr.
23. *A small collection of Pleistocene mammals from Laporte County, Indiana. M. W. Lyon, Jr.
24. Un-natural history derived from native accounts of mammal behavior. T. D. Carter.
25. Remarks upon the behavior in natural habitat of some South American mammals. G. H. H. Tate.
26. Records of North American big game. Wharton Huber.
27. The disk-winged bat (Thyroptera) in Panama. E. R. Dunn.
28. *A new lepticid. H. H. Lane.
29. *Variation in *Palaeosyops leidyi*. H. H. Lane.

30. *Developmental behavior changes in the eastern flying squirrel. R. T. Hatt.

At the meeting of the Directors on May 12, A. Brazier Howell, Corresponding Secretary for the past six years, resigned from office, in order to be able to devote more attention to certain problems he has under investigation. A unanimous vote of thanks was tendered William P. Harris, Jr., for his successful membership campaign during the past year, resulting in the election of 101 new members. The present editorial board (Edward A. Preble, chairman) was continued. H. E. Anthony was reëlected a trustee for the three-year term, 1931–1934. E. Raymond Hall of the University of California, was designated as the Society's representative on a commission to investigate the deer problem in the Kaibab National Forest.

At the annual business meeting of the Society on May 13 the election of officers resulted as follows: president, M. W. Lyon, Jr.; vice-presidents, T. S. Palmer, H. E. Anthony; recording secretary, H. H. Lane; corresponding secretary, Francis Harper; treasurer, Mrs. Viola S. Snyder; directors for 1931–1933, Joseph Grinnell, Remington Kellogg, A. Brazier Howell, W. E. Saunders, Wharton Huber; director to fill vacancy in class of 1930–1932, Lee R. Dice. A vote of thanks was tendered by the Society to A. Brazier Howell for his work in its behalf during his incumbency as corresponding secretary.

The following summary of membership and subscription conditions was presented:

New members elected at the current meeting	101
New subscribers added since last meeting	19
Total gross additions to mailing list of the Journal	120
Resignations since last meeting	41
Deaths since last meeting	8
Number of members delinquent 1931 dues	87
Number of members delinquent 1930 dues	39
Number of honorary members	4
Number of life members	60
Number of annual members	953
Total present membership of the Society	1017
Number of subscribers only	153
Present mailing list of the Journal	966

The eight members lost by death were: Clement Walker Andrews, Edward E. Armstrong, Victor J. Evans, Oliver P. Hay, James S. Hine, Robert T. Jones, William Diller Matthew, and G. Van Gelder.

The Society voted to accept the invitation of Dr. Alexander Wetmore to hold its annual meeting in 1932 at the United States National Museum in Washington.

The following resolution was unanimously adopted:

WHEREAS: The American Society of Mammalogists views with alarm the action taken on the Horn Resolution at the International Zoological Congress held in Padua, Italy, in 1930; therefore,

Be It Resolved: That the American Society of Mammalogists reaffirms its ad-

herence to the International Rules of Zoological Nomenclature as constituted under the 1901 agreement.

At its final business meeting on May 15 the Society passed resolutions expressing appreciation of the facilities and courtesies extended to it by the Academy of Natural Sciences of Philadelphia, the Zoological Society of Philadelphia, and the local committee on arrangements, consisting of James A. G. Rehn (chairman), Morris M. Green, Wharton Huber, and Alexander H. Leighton.

The report by H. E. Anthony, chairman of the Special Committee on Problems of Predatory Mammal Control, was read before the Society on May 14. The report, in full, follows:

REPORT OF THE COMMITTEE ON PROBLEMS OF PREDATORY MAMMAL CONTROL

Because your committee, as individuals, resides in widely separated regions, respectively, in California, Arizona, Michigan and New York, it has been impossible to hold a conference just prior to this annual meeting, for the purpose of preparing a detailed report in concert. However, the chairman has submitted to the various members of the committee a detailed letter asking for endorsement or criticism of the vital and fundamental topics to be presented today, and he has received replies which authorize him to offer a unanimous statement from the committee under the heading of conclusions and recommendations.

Preliminary to this statement the chairman desires to set forth something of the work done by the committee during the past year. As you are aware, your committee has had to conduct its investigations under the handicaps of time and lack of funds. No member of the committee is so situated that he may give all of his time and efforts to such an undertaking. Other work has been subordinated and other interests have been laid aside by the investigators who have gone into the field, and your chairman counts himself as particularly fortunate in having secured the services of competent naturalists willing to make these sacrifices. Institutions and individuals have supported the work with donations and the services of investigators.

A total of $1300.00 was raised and most of this ($1120.00) was expended for traveling expenses. No salaries were paid by the committee, and for the services of five men in the field the American Society of Mammalogists is indebted to The American Museum of Natural History, the California Fish and Game Commission, the California Museum of Vertebrate Zoology, and the University of Arizona. The New York Zoological Society supported the work of the committee by a donation of $500.00 and $800.00 was raised by various raw-fur dealers throughout the West.

The committee field investigators traveled more than 20,000 miles and the actual itinerary in the field exceeded 12,000 miles. Their reports describe conditions for selected areas in Arizona, New Mexico, Texas, California, Nevada, Utah, Colorado, Idaho, and Wyoming. Although these data might indicate that the field work was exhaustive, this was by no means the case, and the results accomplished may be truthfully considered as only a start upon a vast undertaking. However, the committee has in its possession sufficient facts to confirm the opinion of this Society regarding the seriousness of the predatory mammal problem

and to justify the contention that a crisis confronts our native mammals in the western states.

It was the desire of the Society that this committee should coöperate with the Biological Survey, and in-so-far as this was practical the investigations were conducted jointly with Survey representatives. The Chief of the Bureau of Biological Survey has been most considerate throughout the period the committee has functioned, and your chairman has corresponded extensively with him and had the opportunity for several personal conferences as well. The work in the field was begun at times selected by the Survey, except in the case of Mr. Carter, who was a roving investigator and free to choose his own time and place.

Dr. C. T. Vorhies, a member of your committee, also served as a field investigator and studied conditions in Arizona, New Mexico and Texas, working jointly with Dr. Walter P. Taylor of the Biological Survey.

Another committee member, Dr. E. R. Hall, reported upon the situation in California and Nevada. The committee was able to use the services of Mr. E. Lowell Sumner, Jr., a trained investigator of the California Fish and Game Commission, who sent in two long reports upon areas in California. Mr. Sumner coöperated with Mr. E. A. Goldman, of the Survey, for a brief period during the early winter.

Mr. G. G. Goodwin of the American Museum served as a field investigator for the committee and with Mr. S. B. Locke of the Survey carried on a joint study of parts of Idaho, Utah and a bit of Wyoming. During this time Mr. Goodwin also represented the New York Zoological Society.

Mr. T. D. Carter spent some weeks in the states of Colorado, Wyoming, Utah and New Mexico. Mr. Carter reported to the committee upon the complaints from the trappers and raw-fur dealers that the control policy of the Survey was making serious inroads upon the numbers of fur-bearers. He also interviewed leading citizens in every walk of life and his investigations afford a valuable cross-section of public opinion.

All reports sent in to the chairman were copied and forwarded to each member of the committee. At the time that the committee conclusions and recommendations were agreed upon each committee member was in possession of all of the data gathered individually and collectively. Your chairman is presenting, therefore, at this time, not the opinion and judgment of a single member of the committee, himself, but the considered expression of the full committee, of five individuals who have reviewed many pages of testimony.

The Chief of the Biological Survey has displayed an exceedingly fair-minded spirit in mailing to your chairman copies of the reports sent in to him by the Survey field investigators. The committee has, in return, sent copies of the field investigations reported by committee representatives.

In addition to the studies made in the field, most of which were limited to a brief period during the late fall and early winter, your committee has made full use of data gathered at other times and has especially valued as competent testimony the published statements of predatory mammal leaders or other persons in the employ of the Biological Survey whenever their statements have shed a direct light on actual field practices of the Survey.

With this brief outline of the activities of the committee, your chairman has deemed it advisable to pass directly to the conclusions which have been based

only part of the facts and withholding the rest, propaganda which is educating the public to advocate destruction of wild life.

3. That the Society asserts the claim of the great nature-loving public to a voice in the administration of our wild life recources, and challenges the right of a federal organization, such as the Biological Survey, to consider only the interests of a very small minority, the livestock interests.

Mr. President, I move that this report be adopted by the Society. This motion was seconded and, being put to a vote, was carried.

It was further voted to continue this special committee for the ensuing year. Its members are: H. E. Anthony (chairman), Lee R. Dice, M. P. Skinner, Charles T. Vorhies, and E. Raymond Hall.

COMMENTS AND NEWS

A scientific expedition from Harvard University to Australia under the auspices of the Harvard Museum of Comparative Zoology and under the leadership of Professor William Morton Wheeler will leave New York on July 25 to make a study and collection of its fauna. Other members of the expedition include Dr. Glover M. Allen, associate professor of zoology and curator of mammals at the museum; Dr. Ira M. Dixson, medical officers of the expedition, and P. J. Darlington, Ralph Ellis and William Schevill, graduate research workers. (From Science, N.S., vol. 73, p. 698. June 26, 1931.)

Progress in securing legislation that is so sorely needed to provide for the perpetuation of our breeding stock of large whales suffered a delay during the last year, when the time of the Seventy-second Congress was so fully occupied with various sorts of emergency legislation that to secure the consideration of such matters as those pertaining to whaling was utterly out of the question. The Council for the Conservation of Whales has not been idle, however. The Special Committee on Wild Life Resources of the United States Senate, under the chairmanship of Senator Frederic C. Walcott, has concerned itself with the present plight of whales, and has placed the matter under the direct supervision of Senator Peter Norbeck.

This Special Committee held a hearing on whales and whaling on March 20, 1931, at which there testified in behalf of the Council, and therefore of the American Society of Mammalogists, Lewis Radcliffe, T. S. Palmer, Remington Kellogg, and A. Brazier Howell, who briefly outlined the present perilous condition of whales and the whaling industry. The hearing has now been issued in printed form.

At present the Council is not unreasonably hopeful that there may be presented and passed, during the next session of Congress, a bill providing adequate protection for our own supply of whales. Steps are already being taken to endeavor to secure, immediately thereafter, an international agreement for the regulation of whaling.—A. B. H.

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The fourteenth annual meeting of the American Society of Mammalogists will be held at the United States National Museum, Washington, D. C., from Tuesday, May 3, to Saturday, May 7, 1932.

Local committee on arrangements: Wm. M. Mann, chairman, Walter C. Henderson, H. H. T. Jackson, Remington Kellogg, and Ernest P. Walker.

Back volumes of the **Journal of Mammalogy** *are still available as follows:*

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Francis Harper, *Corresponding Secretary*

206 Dickinson Avenue, Swarthmore, Pa.

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